ANL/EAD/TM-108

Depleted Uranium Hexafluoride Management Program: Data Compilation for the Portsmouth Site

in Support of Site-Specific NEPA Requirements for Continued Cylinder Storage, Cylinder Preparation, Conversion, and Long-Term Storage Activities

Environmental Assessment Division
Argonne National Laboratory

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ACKNOWLEDGMENTS

Much of the information in this report was obtained from the *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (PEIS; U.S. Department of Energy Report DOE/EIS-0269, April 1999). The following individuals contributed to the compilation of the PEIS: Timothy Allison, Georgia Anast, John J. Arnish, Halil Avci, Bruce Biwer, Charles E. Bradley, Jr., James Butler, Young-Soo Chang, Jing-Jy Cheng, David Dolak, Stephen Folga, Marsha Goldberg, Larry J. Gorenflo, Rebecca Haffenden, Scott E. Harlow, Heidi Hartmann, Cathy Huss, Deborah Jilek, Kirk LaGory, Timothy T. Long, Frank Mancino, Janet Manual, Gary Marmer, Fred Monette, Marita Moniger, Bassel K. Nabelssi, Lee Northcutt, John M. Pfingston, Anthony J. Policastro, Elisabeth A. Stull, David Tomasko, John Tschanz, Robert VanLonkhuyzen, Bruce Verhaaren, Konnie L. Wescott, Bruce Wilkins, Gary Williams, and Dimis Wyman.

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NOTATION

The following is a list of acronyms and abbreviations, including units of measure, used in this document. Some acronyms used only in tables are defined in those tables.

ACRONYMS AND ABBREVIATIONS

General

ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
AQCR	Air Quality Control Region
BEA	U.S. Bureau of Economic Analysis
CAAA	*Clean Air Act Amendments*
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EBA	evaluation-basis earthquake
EPA	U.S. Environmental Protection Agency
HAP	hazardous air pollutant
HC	hydrocarbons
HEPA	high-efficiency particulate air (filter)
K_d	distribution coefficient
LCF	latent cancer fatality
LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
LMES	Lockheed Martin Energy Systems, Inc.
MCL	maximum contaminant level
MEI	maximally exposed individual
MMES	Martin Marietta Energy Systems, Inc.
MOA	memorandum of agreement
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection and Measurements table
NEPA	*National Environmental Policy Act* of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEIS	programmatic environmental impact statement
PEL	permissible exposure limit

PM_{10}	particulate matter with a mean diameter of 10 :m or less
PUEC	Portsmouth Uranium Enrichment Complex
RCRA	*Resource Conservation and Recovery Act*
ROD	Record of Decision
ROI	region of influence
SAR	safety analysis report
SVOC	semivolatile organic compound
TSCA	*Toxic Substances Control Act*
USEC	United States Enrichment Corporation
VOC	volatile organic compound

Chemicals

AlF_3	aluminum trifluoride
CaF_2	calcium fluoride
CO	carbon monoxide
Fe	iron
HC	hydrocarbons
HF	hydrogen fluoride
Mg	magnesium
MgF_2	magnesium fluoride
NaOH	sodium hydroxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
SO_x	sulfur oxides
TCE	trichloroethylene
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
UO_2	uranium dioxide
UO_2F_2	uranyl fluoride
$UO_2(OH)_2$	uranyl hydroxide
U_3O_8	triuranium octaoxide (uranyl uranate)

UNITS OF MEASURE

Ci	curie(s)	gpm	gallon(s) per minute
cm	centimeter(s)	GWh	gigawatt hour(s)
cm^3	cubic centimeter(s)	ha	hectare(s)
d	day(s)	in.	inch(es)
EF	degree(s) Fahrenheit	kg	kilogram(s)
ft	foot (feet)	km	kilometer(s)
ft^2	square foot (feet)	L	liter(s)
g	gram(s)	lb	pound(s)
gal	gallon(s)	µg	microgram(s)

µm	micrometer(s)
m^3	cubic meter(s)
mg	milligram(s)
min	minute(s)
mrem	millirem(s)
MW	megawatt(s)
MWh	megawatt hour(s)
MWyr	megawatt year(s)
pCi	picocurie(s)
ppm	part(s) per million
psia	pound(s) per square inch absolute
rad	radiation absorbed dose(s)
rem	roentgen equivalent man
scf	standard cubic foot (feet)
scm	standard cubic meter(s)
ton(s)	short ton(s)
yd^3	cubic yard(s)
yr	year(s)

DEPLETED URANIUM HEXAFLUORIDE MANAGEMENT PROGRAM: DATA COMPILATION FOR THE PORTSMOUTH SITE

in Support of Site-Specific NEPA Requirements for Continued Cylinder Storage, Cylinder Preparation, Conversion, and Long-Term Storage Activities

Compiled by
H.M. Hartmann

ABSTRACT

This report is a compilation of data and analyses for the Portsmouth site, near Portsmouth, Ohio. The data were collected and the analyses were done in support of the U.S. Department of Energy (DOE) 1999 *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE/EIS-0269). The report describes the affected environment at the Portsmouth site and summarizes potential environmental impacts that could result from conducting the following depleted uranium hexafluoride (UF_6) management activities at the site: continued cylinder storage, preparation of cylinders for shipment, conversion, and long-term storage. DOE's preferred alternative is to begin converting the depleted UF_6 inventory as soon as possible to either uranium oxide, uranium metal, or a combination of both, while allowing for use of as much of this inventory as possible.

1 INTRODUCTION AND BACKGROUND

This report is a compilation of data and analyses for the Portsmouth site, which were obtained and conducted to prepare the *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (U.S. Department of Energy [DOE] 1999a; hereafter referred to as the PEIS). The PEIS examines alternative management strategies for the long-term storage, use, and disposal of the nation's depleted uranium hexafluoride (UF_6) inventory that falls under the responsibility of DOE. This inventory currently amounts to approximately 700,000 metric tons of depleted UF_6, containing about 476,000 metric tons of uranium. It is stored at three sites: the Paducah site in Kentucky, Portsmouth site in Ohio, and East Tennessee Technology Park in Tennessee. (East Tennessee Technology Park is referred to by its original name, the K-25 site, throughout this report.) The inventory is stored in about 57,700 steel cylinders and includes about 11,200 cylinders of material that have been or will be transferred to DOE from the United States Enrichment Corporation (USEC) under two recent memorandums of agreement (MOAs). Approximately 30% of the above inventory is stored at the Portsmouth site.

The PEIS examines six alternative management strategies (also termed "alternatives"). These include a no action alternative (indefinite continued storage of the depleted UF_6 at the current storage sites) and five action alternatives (long-term storage as UF_6, long-term storage as uranium oxide, use as oxide, use as uranium metal, and disposal). Each of the alternatives would involve some combination of seven activities: continued cylinder storage at the current storage sites, cylinder preparation for shipment, conversion to another chemical form, long-term storage, manufacture and use, disposal, and transportation. This report presents Portsmouth site-specific data from the PEIS for continued storage, cylinder preparation, conversion, and long-term storage activities, as well as data on the existing environment and cumulative impacts at the site.

Under the scope of the current Depleted UF_6 Management Program, additional National Environmental Policy Act (NEPA) documents or environmental information may be required for certain activities. These activities include (1) transporting depleted UF_6 cylinders from one or more of the current storage sites to a site or sites selected for conversion, (2) constructing and operating conversion facilities, (3) constructing additional storage capacity at one or more of the current storage sites, and (4) developing the environmental data required for procurement actions. This report documents the information and results of analyses already obtained and conducted for the Portsmouth site during the preparation of the PEIS, which can serve as a starting point for preparation of site-specific NEPA analyses. This report's compilation of data should provide background for and expedite subsequent environmental assessment and procurement tasks needed to implement the strategy selected in the "Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluorude" (DOE 1999b). However, the data will not be sufficient to completely fulfill NEPA requirements for analyzing conversion or long-term storage activities at the Portsmouth site; more specific information (e.g., process design, activity locations within the site, effluent amounts) will be required for the site-specific NEPA analyses.

The PEIS presents data on the existing environment at the three current storage sites. The information covers ambient air quality, geology and soil, water resources, biotic resources, public and occupational health and safety, socioeconomics, waste management, cultural resources, and the prevalence of minority and low-income populations. These data are presented in Section 2 of this report specifically for the Portsmouth site.

All of the strategies examined in the PEIS consider the impacts that could result from continued storage of cylinders at the three current storage sites for some period of time. In addition, because strategies involving the transportation of the cylinders from their current locations for conversion or long-term consolidated storage would involve the preparation of the cylinders for shipment, the PEIS also reviews the site-specific impacts that could result from cylinder preparation at each of the three sites. The impacts of continued cylinder storage presented in the PEIS are presented in Section 3 of this report specifically for the Portsmouth site. The impacts of cylinder preparation at the Portsmouth site are discussed in Section 4.

In the PEIS, the analyses of the conversion and long-term storage options assumed that the three current storage sites were representative of sites that might actually be used for these activities. Analyses were conducted by using site-specific data (e.g., worker and off-site population distributions, meteorological conditions) for each of the three current storage sites. After the analyses were completed, the results were aggregated and presented as a range that accounted for differences in the sites as well as differences in the technologies that might be used in the future. In this report, ranges of impacts from the different conversion technologies examined in the PEIS are presented in Section 5 specifically for the Portsmouth site. The ranges of impacts from the various long-term storage options examined in the PEIS are presented specifically for the Portsmouth site in Section 6.

Section 7 of this report presents the results of cumulative impact analyses conducted for the Portsmouth site as part of the PEIS. Section 8 gives the results of parametric analyses conducted for conversion and long-term storage at the Portsmouth site. Parametric analyses were included in the PEIS to illustrate the differences in potential environmental impacts if facility capacities were smaller than those assumed for the full-scale analyses. Finally, references are given in Section 9.

The final PEIS included impact analyses for the management of 46,422 cylinders that were filled by DOE before July 1, 1993 (the date USEC took over the operation of the gaseous diffusion plants) and up to an additional 15,000 cylinders generated by USEC (see Chapters 2 and 6 of the PEIS). The impacts that the additional USEC cylinders would have on continued storage, cylinder preparation, conversion, and long-term storage are considered in Sections 3.5, 4.5 , 5.5 , and 6.5 of this document. The number of original DOE cylinders stored at Portsmouth is 13,388. The number of USEC cylinders that have been or will be transferred to DOE is 2,653. However, for the purpose of analysis, the PEIS assumed that the number of cylinders transferred from USEC to DOE at the Portsmouth site would be 3,000.

The detailed methodologies used to conduct the environmental impact assessments presented in this report are documented in Appendix C of the PEIS and in various backup reports to the PEIS. It is beyond the scope of this report to provide the detailed descriptions of methods presented in these other reports; they are referenced as necessary.

2 AFFECTED ENVIRONMENT

Depleted UF_6 is currently managed at three locations: the Paducah site near Paducah, Kentucky; the Portsmouth site near Portsmouth, Ohio; and the K-25 site on the Oak Ridge Reservation near Oak Ridge, Tennessee. The PEIS and this report distinguish the site (the entire DOE facility) from the gaseous diffusion plant (a facility operated by USEC within the larger site) and from the storage yards (the location of the depleted UF_6 cylinders within the site). This section describes the affected environment at the Portsmouth site.

The Portsmouth site is located in Pike County, Ohio, approximately 22 miles (35 km) north of the Ohio River and 3 miles (5 km) southeast of the town of Piketon (Figure 2.1). The two largest cities in the vicinity are Chillicothe, located 26 miles (42 km) north of the site, and Portsmouth, 22 miles (35 km) south.

The Portsmouth site includes the Portsmouth Uranium Enrichment Complex (PUEC), a gaseous diffusion plant previously operated by DOE and currently operated by the USEC. The Portsmouth site occupies 3,708 acres (1,500 ha) of land, with an 800-acre (320-ha) fenced core area that contains the PUEC production facilities. The 2,908 acres (1,180 ha) outside the core area consist of restricted buffers, waste management areas, plant management and administrative facilities, gaseous diffusion plant support facilities, and vacant land (Martin Marietta Energy Systems, Inc. [MMES] 1992b). The PUEC has operated since 1995.

Wayne National Forest borders the plant site on the east and southeast, and Brush Creek State Forest is located to the southwest, slightly more than 1 mile (1.6 km) from the site boundaries. Forests account for more than 60% of the land in Pike County and more than 70% in Scioto County. Neither county has residential land uses exceeding 2% or industrial/commercial land uses exceeding 1%.

No land use maps or comprehensive or master plans have been developed for either Pike County or Scioto County, although the city of Portsmouth is in the process of developing one. The Portsmouth facility has a master plan, which indicates that future land use patterns on the site are expected to remain essentially the same as current conditions (MMES 1992b).

The Portsmouth site is not on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL); environmental remediation activities at the site are overseen under the provisions of the *Resource Conservation and Recovery Act* (RCRA). This discussion of the affected environment at Portsmouth focuses on conditions and contaminants pertinent to depleted UF_6 cylinder management. Some sitewide information from ongoing RCRA investigations is also included to put environmental conditions in the current cylinder storage areas into the context of sitewide conditions.

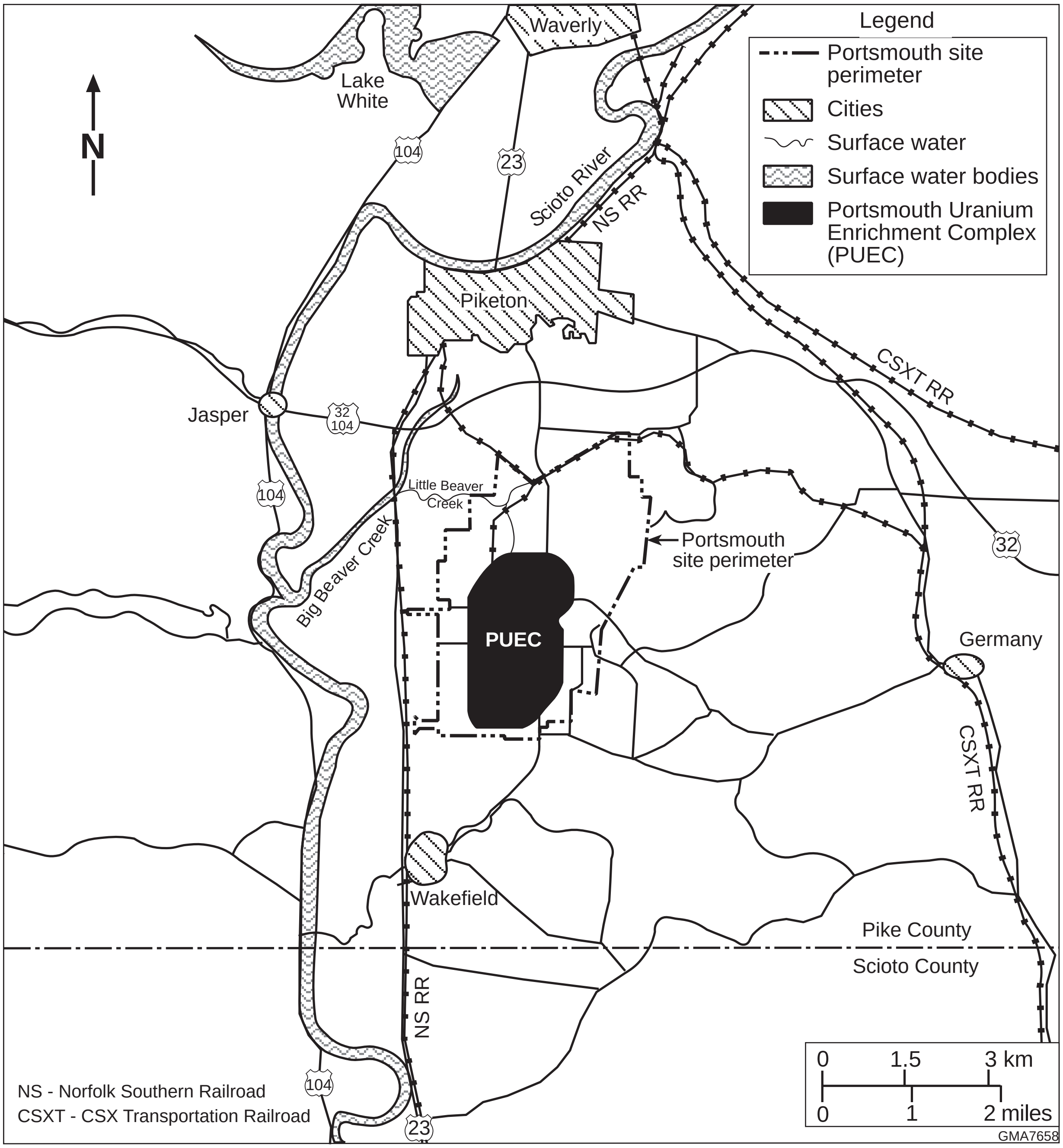

FIGURE 2.1 Regional Map of the Portsmouth Site Vicinity (Source: Adapted from Lockheed Martin Energy Systems, Inc. [LMES] 1996)

2.1 CYLINDER YARDS

The DOE-managed cylinders containing depleted UF_6 at the Portsmouth site are stored in two cylinder yards, X-745-C (C-yard) and X-745-E (E-yard) (Table 2.1; Figure 2.2). These storage yards have concrete bases. The cylinders are stacked two high to conserve yard storage space, with the cylinder-to-cylinder contact typically occurring in the areas of the stiffening rings. All 10- and 14-ton (9- and 12-metric ton) cylinders stored in these yards have been or are being inspected and repositioned. They are being placed on new concrete saddles with sufficient room between cylinders and cylinder rows to permit adequate visual inspection.

TABLE 2.1 Locations of DOE Depleted UF_6 Cylinders at the Portsmouth Site[a]

Yard	Area (ft^2)	Number of Cylinders
X-745-C	550,000	8,988
X-745-E	215,000	4,400

[a] Locations of cylinders as of May 1996.

Source: Cash (1996).

In addition to the DOE-generated cylinders, approximately 2,700 USEC-generated cylinders are stored in X-745-G yard (see Figure 2.2; DOE and USEC 1998a). These cylinders do not meet the 4-ft aisle spacing requirements; therefore, restacking of the cylinders is planned.

Two breached cylinders were identified in C-yard in June 1990; both breaches were attributed to handling damage and subsequent corrosion at the damaged point. One of the breached cylinders had a hole with a diameter of about 2 in. (5.1 cm); the estimated maximum material loss from this cylinder was 4 lb (1.8 kg). The cylinder contents were subsequently emptied into a new cylinder. The other cylinder had a much larger hole of approximately 9 in. × 18 in. (23 cm × 46 cm), with an estimated maximum material loss of about 109 lb (49 kg) (Barber et al. 1994). This cylinder was patched, and the contents were subsequently transferred to a new cylinder.

In March 1978, a cylinder containing liquid depleted UF_6 was accidentally dropped in the south-southwest portion of yard X-745-B (currently a USEC storage yard located north of Building X-330). Much of the material was carried into the storm sewer by melting snow. Cleanup efforts were conducted to collect as much of the lost material as possible; environmental sampling was also conducted to monitor uranium levels subsequent to the release (see Section 2.4).

2.2 SITE INFRASTRUCTURE

The Portsmouth site has direct access to major highway and rail systems, a nearby regional airport, and barge terminals on the Ohio River. Use of the Ohio River barge terminals requires transportation by public road from the Portsmouth site.

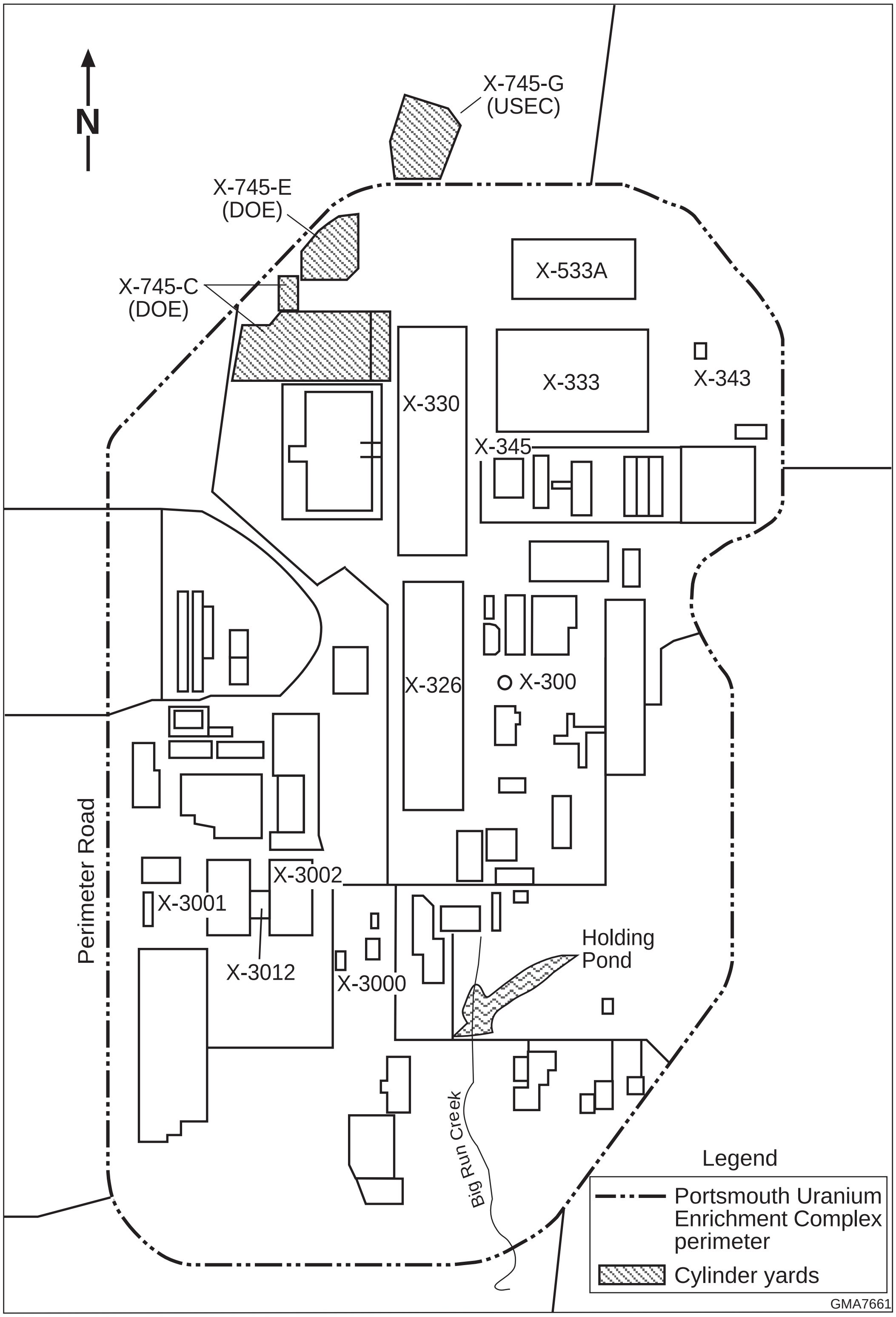

FIGURE 2.2 Locations of Cylinder Yards at the Portsmouth Site That Are Used to Store DOE-Managed Cylinders (Source: Adapted from DOE 1996a and MMES 1992a)

The Portsmouth site draws its water supply from an on-site facility consisting of four wells and from 31 off-site supply wells. Current water usage is about 14 million gal/d (53 million L/d). The maximum site capacity is 38 million gal/d (140 million L/d).

The Ohio Valley Electric Corporation supplies the site with electrical power. The current electrical consumption is 1,537 MW, with additional power supplied by a coal system using 4,500 tons per month. The maximum electrical design capacity is 2,260 MW, but a power supply of only 1,940 MW is guaranteed by the local power utility (MMES 1992b).

2.3 AMBIENT AIR QUALITY AND AIRBORNE EMISSIONS

The affected environment for air quality at the Portsmouth site is generally considered to be the EPA-defined Air Quality Control Region (AQCR). The EPA has designated the Portsmouth site as being in the Wilmington-Chillicothe-Logan AQCR in EPA Region 5. The EPA classifies Pike County, in which the Portsmouth site is located, as an attainment area for all six National Ambient Air Quality Standards (NAAQS) criteria pollutants: carbon monoxide (CO), sulfur oxides (SO_x), particulate matter (PM_{10}, particles with a mean diameter of 10 :m or less), ozone (O_3), nitrogen oxides (NO_x), and lead (Pb). An attainment area for a criteria pollutant is an area that has an ambient air concentration of the pollutant below the corresponding standard.

The State of Ohio has adopted ambient air quality standards for six criteria pollutants that specify maximum permissible short-term and long-term concentrations of these contaminants. These standards are listed in Table 2.2 and are generally the same as the national standards. In addition to standards for criteria pollutants, the Ohio Environmental Protection Agency has adopted emissions limits, guidelines, and acceptable ambient concentration levels for the 189 hazardous air pollutants (HAPs) specified in Section 112(b) of the *Clean Air Act Amendments* (CAAA). Regulations for these HAPs are established in the National Emission Standards for Hazardous Air Pollutants (NESHAP) (*Code of Federal Regulations*, Title 40, Part 61 [40 CFR Part 61]).

Gaseous radiological emissions were monitored at one active source during 1996. The total discharge of uranium to the air from DOE sources at Portsmouth in 1996 was less than 0.01 Ci, a reduction of more than 90% compared with the 1994 total. The active source has been transferred to USEC responsibility, leaving DOE responsible for a single radiological source that is currently inactive (LMES 1997e).

Nonradiological emissions consisted mainly of fugitive dust. Other small sources of pollutants emitted chlorine, hydrogen fluoride (HF), methanol, assorted solvents, and coolants. The emission of the HAP trichloroethylene (TCE), several hundred gallons of which were collected in groundwater treatment facilities, was prevented by activated carbon filtration of the treatment facility air stripper off-gases (LMES 1997e).

TABLE 2.2 Ohio Ambient Air Quality Standards

	Ohio Standard[a]	
Pollutant	Primary	Secondary
Carbon monoxide (CO)		
1-hour average	35 ppm[b]	35 ppm
8-hour average	9 ppm	9 ppm
Sulfur oxides (SO_x)		
3-hour average	–[c]	0.50 ppm
24-hour average	0.14 ppm	–
Annual average	0.03 ppm	–
Particulate matter (PM_{10})		
24-hour average	150 $\mu g/m^3$	150 $\mu g/m^3$
Annual arithmetic mean	50 $\mu g/m^3$	50 $\mu g/m^3$
Ozone (O_3)		
1-hour average	0.12 ppm	0.12 ppm
Nitrogen oxides (NO_x)		
Annual average	0.053 ppm	0.053 ppm
Lead (Pb)		
Quarterly average	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$
Gaseous fluorides (as HF)	NS[d]	NS

[a] Annual standards are never to be exceeded; short-term standards are not to be exceeded more than once per year, unless noted.

[b] ppm = part(s) per million.

[c] A hyphen (–) indicates that no standard is available for this averaging period.

[d] Ohio has no standard for gaseous fluorides.

Source: DOE (1996a).

2.4 GEOLOGY AND SOIL

2.4.1 Topography, Structure, and Seismic Risk

The topography of the Portsmouth site area consists of steep hills and narrow valleys, except where major rivers have formed broad floodplains. The site is underlain by bedrock of shale and sandstone.

The Portsmouth site is within 60 miles (96 km) of the Bryant Station-Hickman Creek Fault (Argonne National Laboratory [ANL] 1991). No correlation has been made between this fault and historical seismicity. Seismic Source Zone 60 is a north-northeast-trending zone in central and eastern Ohio and includes the Portsmouth facility. For this site, the evaluation-basis earthquake (EBE) was designated by DOE to have a return period of 250 years. A detailed analysis indicated that the peak ground motion for the EBE was approximately 0.06 times the acceleration of gravity (LMES 1997g). An earthquake of this size would have an equal probability of occurring any time during a 250-year period.

The seismic hazards at the Portsmouth site have been analyzed and documented in a safety analysis report (SAR) completed in March 1997 (see Sections 1.5 and 3.3 in LMES 1997g). The results presented in the SAR indicate that continued storage of depleted UF_6 cylinders at the Portsmouth site is safe. The results of the SAR analyses were used for the accident analyses in Appendix C, Section C.4.2, of the PEIS. A spectrum of accidents was considered, ranging from those having a high probability of occurrence but low consequences to those having high consequences but a low probability of occurrence. Natural phenomena accidents including earthquakes, floods, and tornadoes were among the accidents considered.

2.4.2 Soil

The substances in soil that might be associated with cylinder management activities at the Portsmouth site are uranium and fluoride compounds, which could be released if breached cylinders or faulty valves were present. In 1993, soil was sampled for radioactive parameters and chromium at 23 on-site, 32 off-site, and 4 background locations; soil sample analyses indicated no major environmental contamination (MMES 1994a). Analytical results for all off-site and most on-site sampling locations were similar to background values (MMES 1994b). One on-site sampling point (RIS-19, adjacent to the X-705 decontamination building) was contaminated with technetium-99 (143 pCi/g) and low levels of uranium (45 μg/g). This area is known to be contaminated from historical small spills; the source of uranium was not considered to be cylinder storage yards. Chromium concentrations were elevated at two locations immediately adjacent to and downwind of the X-633 cooling towers. Fluoride has not been analyzed in soil samples, but it is naturally occurring in soils and of low toxicity. Soils data have not been reported in more recent annual environmental reports (LMES 1996, 1997e).

After the March 1978 cylinder handling accident (see Section 2.1), soil samples were collected to determine whether the X-745-C and X-745-B yards were contaminated (Geraghty & Miller 1994a,b). Total uranium concentrations in the X-745-C yard did not appear to be elevated, ranging from 2.2 to 4.4 mg/kg. Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs) were detected in shallow soil samples at maximum levels up to about 3 mg/kg (for polycyclic aromatic hydrocarbons [PAHs]). Although a few VOCs were detected at low concentrations in groundwater from one well, the source is unlikely to be the X-745-C yard (Geraghty & Miller 1994a).

Total uranium concentrations in the X-745-B yard were elevated in some soil samples, ranging from 2.7 to 352 mg/kg. The source of the uranium contamination might have been the 1978 spill. Some VOCs, SVOCs, and PCBs were also detected in shallow soil samples at maximum levels up to 31 mg/kg (for the PAH phenanthrene). However, no uranium, VOCs, SVOCs, or PCBs were detected in groundwater associated with the X-745-B yard. The contamination was confined to shallow soils and limited to the immediate proximity of the unit (Geraghty & Miller 1994b).

2.5 WATER RESOURCES

The affected environment for water resources consists of surface water within and in the vicinity of the site boundary and groundwater beneath the site. Analyses of surface water, stream sediment, and groundwater samples indicated the presence of some contamination resulting from previous gaseous diffusion plant operations. Although several contaminants are present in the water, only small amounts of uranium and fluoride compounds are related to releases from the cylinders.

2.5.1 Surface Water

The Portsmouth site is drained by several small tributaries of the Scioto River (see Figure 2.1). The largest stream on the plant property is Little Beaver Creek, which drains the northern and northeastern portions of the site before discharging into Big Beaver Creek. Upstream of the plant, Little Beaver Creek flows intermittently during the year. On site, it receives treated process wastewater from a holding pond (via the east drainage ditch) and storm-water runoff from the northwestern and northern sections of the plant via several storm sewers, watercourses, and the north holding pond. The average release to Little Beaver Creek for 1993 was 940 gal/min or gpm (3,600 L/min).

All plant liquid effluents are regulated by a National Pollutant Discharge Elimination System (NPDES) permit and are either discharged to Little Beaver Creek or piped directly to the Scioto River (Rogers et al. 1988). The Portsmouth site has 21 NPDES-permitted outfalls, of which 9 required routine monitoring in 1993. The maximum annual average uranium concentration (0.024 mg/L) for 1993 was measured at NPDES outfall 003 on the west side of the site (MMES 1994a). Responsibility for all but two of these outfalls has been transferred to the USEC. The maximum uranium concentration in these two outfalls in 1996 sampling was 0.002 mg/L (LMES 1997d).

In addition to NPDES outfall monitoring, surface water bodies were monitored for radioactive and nonradioactive contamination at one on-site and nine off-site locations, which include upstream and downstream locations on the Scioto River. The surface water monitoring results for 1993 indicated that the measured radioactive contamination was consistently less than the applicable drinking water standards (MMES 1994b). In 1996, TCE was detected in one sampling round for Little Beaver Creek. The TCE levels returned to below detection limits by the fourth quarter of 1996, after an interceptor trench and pump were repaired (LMES 1997e).

In addition to surface water sampling, sediment sampling was performed twice in 1993 to monitor for potential radioactive contamination. The fall-quarter sediment sampling results indicated minor radioactive contamination in Little Beaver Creek sediments downstream of the east drainage ditch (MMES 1994b). Uranium was elevated only slightly at about 7 to 11 µg/g (MMES 1994a). Technetium-99 was present at an activity level of about 130 to 160 pCi/L in Little Beaver Creek below the site. No uranium contamination was detected in Big Beaver Creek downstream of the confluence with Little Beaver Creek; however, technetium-99 was measured at 23 pCi/g in the spring and 55 pCi/g in the fall. No radioactive contamination was detected in sediments from Big Run Creek or the Scioto River. Sediment data were not reported in more recent annual environmental reports (LMES 1996, 1997e).

Results for 1993 for nonradioactive constituents indicated the presence of iron and zinc contamination in the streams (MMES 1994b). Fluoride and phosphate concentrations have also been monitored at upstream and downstream locations on the Scioto River. Results of this monitoring indicate no major difference between upstream and downstream concentrations of either chemical.

In addition, unusually high concentrations of thallium (up to about 400 mg/kg) were detected in Scioto River sediments in 1993 and 1994 (MMES 1994a; Manuel 1998). These high measurements may have been caused by an analytical laboratory problem (MMES 1994a). Levels at the same locations in 1995, 1996, and 1997 were much lower, ranging from less than 3 to 19 mg/kg (Manuel 1998).

2.5.2 Groundwater

Five hydrologic units at the Portsmouth site are important for groundwater flow and contaminant migration. These units are, in descending order, the Minford Clay, Gallia Sand, Sunbury Shale, Berea Sandstone, and Bedford Shale. The upper two units form an aquifer in unconsolidated deposits; the lower three units form a bedrock aquifer. At the site, the hydraulic conductivity (rate at which water moves) of all units is very low (Geraghty & Miller 1989). The most conductive unit is the Gallia Sand, which has a mean hydraulic conductivity of 3.4 ft/d (0.0012 cm/s) and a range of 0.11 to 150 ft/d (0.000039 to 0.05 cm/s). This unit acts as the principal conduit for contaminant transport.

The direction of groundwater flow beneath the Portsmouth site is controlled by a complex interaction between the Gallia and Berea units (Geraghty & Miller 1989). The flow patterns are also affected by the presence of storm sewers and the reduction in recharge caused by the presence of buildings and paved areas. Three main discharge areas exist for the groundwater system beneath the site: Little Beaver Creek to the north and east; Big Run Creek to the south; and two unnamed drainages to the west (Geraghty & Miller 1989).

Although the Portsmouth site could use Scioto River water, all on-site water is currently supplied by wells. Four wells have the capacity to supply between 23.5 and 26 million gal/d (89 and 98 million L/d). Currently, about 14 million gal/d (53 million L/d) of groundwater is used for sanitary and production needs (ANL 1991). Recharge of the aquifers is from river and stream flow as well as from precipitation.

On-site groundwater at the Portsmouth site is monitored for radioactive and nonradioactive constituents at more than 245 wells. Additional off-site wells are used to monitor groundwater quality away from the site. On site, three areas of groundwater contamination have been identified (Figure 2.3) that contain contaminants, including TCE, Freon-113, uranium, and technetium. In 1996, the maximum detected concentration of uranium was 26 :g/L for an on-site well in the X-701B holding pond area adjacent to Building X-333 (see Figure 2.3) (LMES 1997d).

2.6 BIOTIC RESOURCES

2.6.1 Vegetation

The Portsmouth site within the perimeter road consists primarily of open grassy areas, including frequently mowed lawns, pasture, and old-field. Small areas of pine plantation, upland mixed hardwood forest, oak-hickory forest, bottomland mixed hardwood forest, and shrub thicket also occur on the site (DOE 1995).

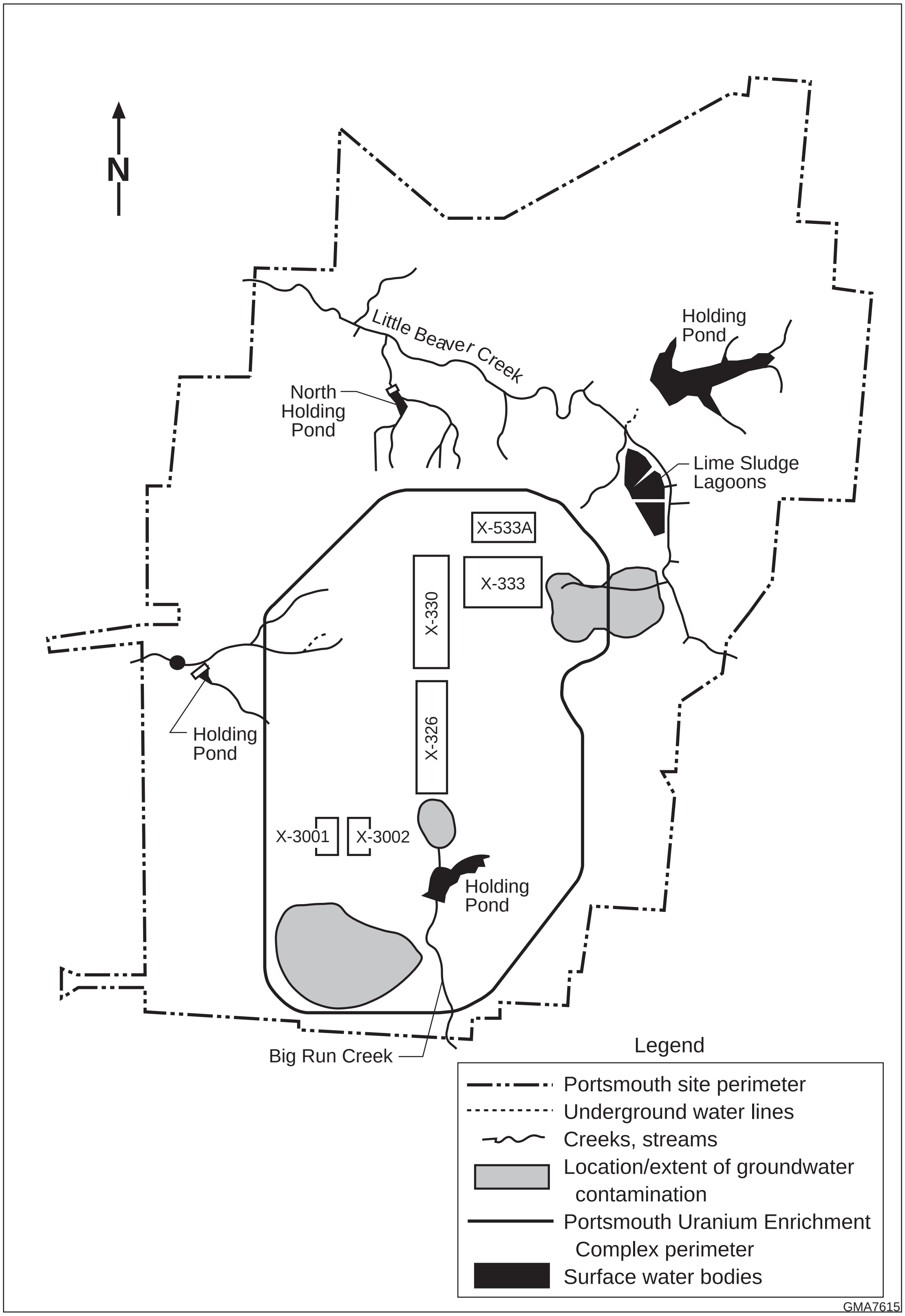

FIGURE 2.3 Locations of Contaminated Groundwater at the Portsmouth Site (Source: LMES 1996)

2.6.2 Wildlife

Habitats on the Portsmouth site support a relatively high diversity of terrestrial and aquatic wildlife species. Ground-nesting species include bobwhite and eastern box turtle. Various species of reptiles and amphibians are associated with streams and other surface water on the site. Migrating waterfowl use site retention ponds (ANL 1991). Additional information on wildlife resources is available from MMES (1993) and ANL (1991).

Little Beaver Creek, upstream of the site outfall, supports a high diversity of aquatic species. However, diversity is considerably lower downstream in Little Beaver Creek and in an unnamed stream (ANL 1991).

2.6.3 Wetlands

A wetland survey of the Portsmouth site was conducted in 1995. Approximately 34 acres (13.8 ha) of wetlands occur on the site, excluding retention ponds. Forty-one wetlands meet the criteria for jurisdictional wetlands, while four wetlands are nonjurisdictional (Bechtel Jacobs Company LLC 1998). Wetlands on the site primarily support emergent vegetation that includes cattail, great bulrush, and rush. Palustrine forested wetlands occur on the site along Little Beaver Creek (ANL 1991). The Ohio State Division of Natural Areas and Preserves has listed two wetland areas near the site as significant wetland communities: (1) a palustrine forested wetland, about 5 miles (8 km) east of the site, and (2) Givens Marsh, a palustrine wetland with persistent emergent vegetation, about 2.5 miles (4 km) northeast of the site.

2.6.4 Threatened and Endangered Species

No federal-listed plant or animal species are known to occur on the Portsmouth site. The Indiana bat, federal- and state-listed as endangered, has been reported in the site area and may occur on the site during spring or summer in breeding colonies. Roosting and nursery sites may include forested areas with loose barked trees (such as shagbark hickory) and standing dead trees (DOE 1995).

The sharp-shinned hawk, listed by the State of Ohio as endangered, has been sighted occasionally at the Portsmouth site and has been observed foraging on the site (ANL 1991). A population of long-beaked arrowhead, a wetland plant listed by the state as threatened, occurs just north of the site.

2.7 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

2.7.1 Radiation Environment

Operations at the Portsmouth site result in exposures of on-site workers and members of the general public to radiation (Table 2.3). The maximum total radiation dose to an off-site member of the public as a result of gaseous diffusion plant operations is estimated to be 0.07 mrem/yr, which is less than 0.02% of the average dose of 360 mrem/yr that an individual in the United States receives each year from natural background and medical sources of radiation.

Radiation exposures of the cylinder yard workers include exposures from activities performed outside the cylinder yards. The average dose ranged from 55 to 196 mrem/yr between 1990 and 1995 (Hodges 1996), considerably below the maximum dose limit of 5,000 mrem/yr set for workers (10 CFR Part 835).

2.7.2 Chemical Environment

Estimated hazard quotients for members of the general public under existing environmental conditions near the Portsmouth site are presented in Table 2.4. The hazard quotient represents a comparison of estimated human intake levels with intake levels below which adverse effects are very unlikely to occur (see Chapter 4 of the PEIS for further details). The estimated hazard quotients indicate that exposures to uranium, fluoride, and chromium for members of the general public near the Portsmouth site are much lower than those that might be associated with adverse health effects.

The Occupational Safety and Health Administration (OSHA) has proposed permissible exposure limits (PELs) for uranium compounds and HF in the workplace (29 CFR Part 1910, Subpart Z, as of March 1998), as follows: 0.05 mg/m^3 for soluble uranium compounds and 2.5 mg/m^3 for HF. Paducah worker exposures are kept below these limits.

2.8 SOCIOECONOMICS

The socioeconomic environment of the Portsmouth site was assessed in terms of regional economic activity, population and housing, and local public finances. The region of influence (ROI) consists of Jackson, Pike, Ross, and Scioto Counties in Ohio; 92.4% of employees at the site currently reside in these counties, with 46% residing in Scioto County (DOE 1996b). Allison and Folga (1997) provide a listing of the cities and school districts in each county within the ROI, together with supporting data for the socioeconomic characteristics described in this section.

TABLE 2.3 Estimated Radiation Doses to Members of the General Public and to Uranium Material Handlers at the Portsmouth Gaseous Diffusion Plant

Receptor	Radiation Source	Dose to Individual (mrem/yr)
Member of the general public (MEI)[a]	Routine site operations	
	Airborne radionuclides	0.016[b]
	Waterborne radionuclides	0.006[c]
	Direct gamma radiation	~0[d]
	Ingestion of foodstuffs	~0.044[e]
Uranium material handler[f]	External radiation	55 – 196[g]
Member of public or worker	Natural background radiation and medical sources	360[h]
DOE worker limit		2,000[i]

[a] The MEI was assumed to reside at an off-site location that would yield the largest dose. An average person would receive a radiation dose much less than the values shown in this table.

[b] Radiation doses from airborne releases were estimated using air concentrations calculated by an air dispersion model (LMES 1996).

[c] The MEI was assumed to use the Scioto River as a source of drinking water and for fishing and recreation (LMES 1996).

[d] Radiation levels around the site could result in doses about the same as those from off-site radiation levels (LMES 1996).

[e] Radiation doses could result from consumption of locally produced foodstuffs (including fish caught in the Scioto River). Estimated doses were obtained by subtracting doses from airborne and waterborne radionuclides from the total dose (0.07 mrem/yr) received by the MEI (LMES 1996).

[f] Uranium material handlers at the Portsmouth plant perform feed and withdrawal operations, cylinder movements, inspections, and radiation surveys (Hodges 1996).

[g] Range of annual average doses from years 1990 through 1995 (Hodges 1996).

[h] Average dose to a member of the U.S. population as estimated in Report No. 93 of the National Council on Radiation Protection and Measurements (NCRP 1987).

[i] DOE administrative procedures limit DOE workers to 2,000 mrem/yr (DOE 1992), whereas the regulatory dose limit for radiation workers is 5,000 mrem/yr (10 CFR Part 835).

TABLE 2.4 Estimated Hazard Quotients for Members of the General Public near the Portsmouth Site under Existing Environmental Conditions[a]

Environmental Medium	Parameter	Assumed Exposure Concentration	Estimated Chronic Intake (mg/kg-d)	Reference Level[b] (mg/kg-d)	Hazard Quotient[c]
Air[d]	Uranium	< 0.01 : g/m^3	< 4.3×10^{-6}	0.0003	0.0095
	HF	< 0.11 : g/m^3	< 3.1×10^{-5}	0.02	0.0016
Soil[e]	Uranium	5.3 mg/kg	7.0×10^{-5}	0.003	0.024
	Chromium	23 mg/kg	3.0×10^{-4}	0.005	0.060
Surface water[f]	Uranium	24 : g/L	1.3×10^{-5}	0.003	0.0044
	Fluoride	600 : g/L	3.3×10^{-4}	0.06	0.0055
Sediments[f]	Uranium	11 mg/kg	3.0×10^{-6}	0.003	0.0010
Groundwater[g]	Uranium	26 : g/L	6.9×10^{-5}	0.003	0.25

[a] The receptor was assumed to be a long-term resident near the site boundary or other off-site monitoring location that would have the highest concentration of the contaminant being addressed; reasonable maximum exposure conditions were assumed. Only the exposure pathway contributing the most to intake levels was considered (i.e., inhalation for air and ingestion for soil, sediment, surface water, and groundwater). Residential exposure scenarios were assumed for air, soil, and groundwater analyses; recreational exposure scenarios were assumed for surface water and sediment analyses.

[b] The reference level is an estimate of the daily human exposure level that is likely to be without an appreciable risk of deleterious effects. The reference levels used in this assessment are defined in Appendix C of the PEIS.

[c] The hazard quotient is the ratio of the intake of the human receptor to the reference level. A hazard quotient of less than 1 indicates that adverse health effects resulting from exposure to that chemical alone are highly unlikely.

[d] Property-line sampling locations were used for assessment of general public exposures. Gross alpha was reported, which was used as a surrogate for uranium. Air exposure concentrations are the maximum annual average reported for all property-line and off-site monitoring locations (LMES 1996).

[e] Soil exposure concentrations are the maximum values from 32 property-line and off-site sampling locations (MMES 1994a).

[f] Surface water and sediment exposure concentrations are the maximum annual averages reported for all NPDES outfall locations and other monitoring locations (MMES 1994a,b).

[g] Groundwater exposure concentration is the maximum concentration reported for on-site monitoring wells (LMES 1997d). These wells are not used for drinking water. Several additional substances exceeded drinking water standards or guidelines in 1996 (see Section 2.5.2); listed here are only substances of particular interest for the PEIS. Groundwater fluoride concentrations were not available.

2.8.1 Regional Economic Activity

Employment in the ROI rose relatively steadily between 1980 and 1995, growing from 75,600 to 81,000, an increase of 7.1%. Within the ROI, the largest percent employment increase occurred in Pike County (19.1%). Employment in the ROI is concentrated in Ross and Scioto Counties, which together had 71.1% of the ROI total in 1995. The BEA projects no overall increase in employment in the ROI over the period 1995 to 2020. However, Pike County (2.0%, 200 jobs) and Scioto County (0.4%, 100 jobs) are expected to gain in ROI employment, with losses expected elsewhere (U.S. Bureau of Economic Analysis [BEA] 1996). Unemployment in the ROI in 1996 was 9.3% (Allison 1996). Employment at the Portsmouth site in 1995 was 2,400 (DOE 1997), amounting to approximately 3.0% of total employment in the ROI.

Personal income in the ROI rose relatively steadily between 1980 and 1995, growing from \$1.8 billion to \$2.0 billion, an increase of 11%. The largest percent increase occurred in Pike County (41.7%). Personal income is concentrated in Ross and Scioto Counties, which together had 75.1% of total ROI personal income in 1995. The BEA projects a 26.8% increase in ROI personal income from 1995 to 2020 (\$0.5 billion), with the largest increase in Pike County (38.2%, \$0.09 billion) (BEA 1996).

2.8.2 Population

The ROI experienced small increases in population over the period 1980 to 1995, with total population growing from 202,900 to 205,200, an increase of 1.1%. The 1995 ROI population was concentrated in Ross and Scioto Counties (73.3%). The BEA projects the ROI population to increase by 9,800 (4.8%) from 1995 to 2020, with the largest increase in Pike County (7.7%, 1,900 people) (BEA 1996).

2.8.3 Housing

Between 1980 and 1995, the number of housing units in the ROI increased 6.5%, from 75,800 to 80,800. Scioto and Ross Counties had 73.1% of the total housing units. Based on BEA (1996) population forecasts for 1995 to 2020 and U.S. Bureau of the Census (1994) statistics, the number of vacant owner-occupied units in the ROI is expected to increase from 4,630 to 4,850 and the number of vacant rental units from 1,940 to 2,030.

2.8.4 Public Finance

The financial characteristics of local public jurisdictions included in the ROI are summarized in Table 2.5. Data are shown for the major revenue and expenditure categories and for the annual fiscal balance of the general fund account for cities, counties, and school districts.

2.9 WASTE MANAGEMENT

The affected environment with respect to waste management is considered to be wastewater and solid waste generated at the Portsmouth site. Disposal of this waste is currently managed by USEC, including any waste generated from ongoing management of the DOE-generated depleted UF_6 cylinders currently in storage. The cylinder storage yards at Portsmouth currently generate only a very small amount of waste compared with the volume of waste generated from ongoing plant operations. Cylinder yard waste consists of small amounts of metal, scraping from cylinder maintenance operations, potentially contaminated soil, and miscellaneous items.

The Portsmouth site generates several categories of waste, including wastewater, solid low-level radioactive waste (LLW), solid and liquid low-level mixed waste (LLMW), nonradioactive hazardous waste, and nonradioactive nonhazardous solid waste. The site has an active program to minimize the generation of solid LLW, hazardous waste, and LLMW. Radioactive waste minimization efforts include segregating radioactive waste from nonradioactive waste; reduction of radiologically controlled areas, thereby reducing the use of disposable personal protective equipment; and improved segregation and handling of laboratory waste. Hazardous and mixed waste minimization actions include the sorting of burnable waste from radioactively contaminated materials, reduction of absorbent cloth use in PCB spill cleanup, reduction in floor sweeping waste, and substitution of materials containing nonhazardous components. Solid waste minimization actions include the recycling of corrugated cardboard and aluminum.

The Portsmouth site and nationwide waste loads assumed for the analysis of impacts of projected activities in this report are given in Table 2.6. Details on the waste management impact assessment methods are provided in Appendix C of the PEIS.

2.9.1 Wastewater

Wastewater at Portsmouth consists of nonradioactive sanitary and process-related wastewater streams, cooling water blowdown, radioactive process-related liquid effluent, discharges from groundwater treatment systems, and storm-water runoff from plant areas, including runoff from the coal pile. Wastewater is processed at several on-site treatment facilities and is discharged to either the Scioto River or its immediate tributaries, including Little Beaver Creek, through

TABLE 2.5 Summary of Financial Characteristics for the Portsmouth Site County, City, and School District Regions of Influence

Category	Finances[a] ($ million) ROI Counties	ROI Cities	Category	Finances[a] ($ million) ROI School Districts
Revenues			**Revenues**	
Local sources	18.1	13.1	Local sources	22.8
Fines, fees, permits, etc.	3.3	3.2	State sources	33.6
Intergovernmental	3.7	4.1	Federal sources	4.6
Other	3.0	3.4	Other	0.2
Total	28.1	23.8	Total	61.2
Expenditures			**Expenditures**	
General government	12.1	6.7	Administration	0.0
Safety, health, community services	8.6	14.3	Instruction	36.9
			Services	23.4
Debt service	0.0	0.0	Physical plant	0.4
Other financing sources	7.6	2.5	Other	2.0
Total	28.3	23.6	Total	62.8
Revenues less Expenditures	-0.2	0.2	**Revenues less Expenditures**	-1.6

[a] Data for fiscal year ending December 31, 1994.

Source: Allison and Folga (1997).

21 outfalls identified under the site NPDES permit. Treatment facilities include an activated sludge sewage treatment plant; several facilities that employ waste-specific pretreatment technologies (e.g., pH adjustment, activated carbon adsorption, metals removal, denitrification, and ion absorption); and numerous settling basins designed to facilitate solids settling, oil collection, and chlorine dissipation. In 1993, about 4.3 million gal/d (16 million L/d) of wastewater was discharged through the permitted outfalls. The site wastewater facilities are used at about 80% of a total capacity of approximately 5.3 million gal/d (20 million L/d) (DOE 1996a).

2.9.2 Solid Nonhazardous, Nonradioactive Waste

Solid waste — including sanitary refuse, cafeteria waste, industrial waste, disinfected medical waste (excluding drugs), and construction and demolition wastes — is collected and disposed of on-site at the X-735 sanitary landfill. Disposal is in shallow trenches covered with

TABLE 2.6 Projected Site and National DOE Waste Treatment Volumes

	Waste Treatment Volume[a] (m^3/yr)	
Waste Category	Portsmouth	Nationwide
Low-level waste[b]	4,800	68,000[c]
Low-level mixed waste[d]	1,600	19,000[c]
Hazardous waste[e]	120	-
Nonhazardous waste[e]		
Solids	-	-
Wastewater	-	-
Sanitary waste	500,000	-

[a] A hyphen (–) indicates no data reported.

[b] Source: DOE (1995b).

[c] Estimated operational waste for 1995 for all DOE sources combined (DOE 1997).

[d] Source: DOE (1995c).

[e] Source: DOE (1996a).

earthen fill. The site operates the landfill under an annual permit issued by Pike County, Ohio. No RCRA hazardous waste, PCB waste, or radioactive materials are allowed in the landfill. Asbestos waste is disposed of in specially designated areas of the sanitary landfill. In 1993, the landfill load was 236,000 yd^3 (180,000 m^3), which represented 86% of the landfill capacity of 273,000 yd^3 (209,000 m^3) (DOE 1996a).

Materials, such as certain construction and demolition debris, that are not regulated as solid waste by the state of Ohio are disposed of at the Portsmouth X-736 construction spoils area, located immediately west of the sanitary landfill.

2.9.3 Nonradioactive Hazardous and Toxic Waste

Nonradioactive waste that is considered hazardous waste according to RCRA or contains PCBs as defined under the *Toxic Substances Control Act* (TSCA) requires special handling, storage, and disposal. The Portsmouth site generates hazardous waste, including spent solvents and heavy-metal-contaminated waste, and PCB-contaminated toxic waste. As of 1994, Portsmouth had a RCRA

Part B permit application pending before the Ohio Environmental Protection Agency. Portsmouth provides long-term on-site storage for hazardous waste at the X-7725 and X-326L RCRA container storage units. Several additional 90-day satellite storage areas are available for temporary storage of hazardous waste. In 1993, the site had 7,200 yd^3 (5,500 m^3) of hazardous waste in storage; site storage capacity is 9,700 yd^3 (7,400 m^3) (DOE 1996a).

Hazardous waste is sent to permitted off-site contractors for final treatment and/or disposal. Annual generation of solid hazardous waste ranged from 130 to 160 yd^3/yr (100 to 120 m^3/yr) in 1991 and 1992, respectively. Much of the hazardous waste load consists of PCB-contaminated waste. The site has over 2×10^6 lb (900,000 kg) of PCBs in various site electrical equipment in both active and inventory equipment (1993 data). In 1992, about 325 yd^3 (250 m^3) of hazardous organic liquid waste streams was sent to the K-25 site TSCA-approved incinerator. The capacity of the incinerator is 1,800 yd^3/yr (1,400 m^3/yr) (DOE 1996a).

2.9.4 Low-Level Waste

LLW generated at the Portsmouth site is stored on-site pending shipment to off-site treatment/disposal facilities. Portsmouth has initiated shipment of some LLW to the Hanford site (Washington) for disposal. Solid LLW generated at the site includes refuse, sludge, and debris contaminated with radionuclides, primarily uranium and technetium. As of 1995, 38,600 yd^3 (29,500 m^3) of LLW was in storage at the Portsmouth site (DOE 1996a). The annual generation of solid LLW was 2,920 yd^3 (2,230 m^3) in 1991, 2,160 yd^3 (1,650 m^3) in 1992, and approximately 6,300 yd^3 (4,800 m^3) in 1993.

2.9.5 Low-Level Mixed Waste

LLW that contains PCBs or RCRA hazardous components is considered to be LLMW. All of the LLMW inventory at Portsmouth is subject to RCRA land disposal restrictions; LLMW is currently stored at the site. Treatment technologies exist for all of the LLMW streams in the Portsmouth inventory. As of 1995, 7,290 yd^3 (5,570 m^3) of mixed waste was in storage at the site. Of this, approximately 18% was derived from operations, and the rest was packaged solvent and/or metals-contaminated soil from environmental restoration activities. Mixed waste generation in 1992 was 510 yd^3 (390 m^3) liquid and 460 yd^3 (350 m^3) solid; the LLW generation rate for 1993 was about 2,100 yd^3 (1,600 m^3). In 1992, approximately 558,000 lb (254,000 kg) of organic liquid LLMW was sent to the TSCA incinerator or the K-25 site (DOE 1996a). In 1995 and 1996, approximately 1,300 yd^3 (1,000 m^3) of contaminated soil (LLMW) was shipped to a commercial facility in Utah for disposal.

2.10 CULTURAL RESOURCES

As of 1997, an archaeological survey had been initiated at the Portsmouth site but not completed. A survey conducted in 1952 recorded no sites. However, because of the archaeological site density in the surrounding area (over 200 sites have been recorded for Pike County alone), there is potential for discovering sites at Portsmouth using modern archaeological methods.

As of 1997, an inventory of historic buildings had been planned but not conducted at the Portsmouth site. It is likely that buildings related to uranium enrichment and atomic weapons manufacture would be eligible for the *National Register of Historic Places*. Two cemeteries, Holt Cemetery and Mount Gilead Cemetery, are located within the boundary of the facility.

No religious or sacred sites, burial sites, or resources significant to Native Americans have been identified at the Portsmouth site to date.

2.11 MINORITY AND LOW-INCOME POPULATIONS

Demographic information obtained from the U.S. Bureau of the Census was used to profile the population residing within a 50-mile (80-km) radius of the Portsmouth site. A 50-mile (80-km) radius was selected because it would capture virtually all of the human health risks and environmental impacts that could potentially occur. A geographic information system based on 1990 Census Bureau *Tiger Line Files* and Summary Tape Files 1 and 3A was used to generate a map illustrating minority and low-income populations residing within the 50-mile (80-km) zone of impact surrounding the site (U.S. Bureau of the Census 1992a,b,c).

The unit of analysis was the census tract. For those census tracts only partially located inside a 50-mile (80-km) radius of the site, an even population distribution was assumed, and the population was calculated as a proportion of the tract area physically located within the 50-mile (80-km) radius (i.e., if 50% of the census area was inside the 50-mile (80-km) radius, then 50% of its population was counted). The map, which is presented in Figure 2.4, depicts the distribution of minority and low-income census tracts within a 50-mile (80-km) radius of the Portsmouth site. Information regarding the proportion of the total population residing within 50 miles (80 km) of the site that is minority or low-income accompanies the figure.

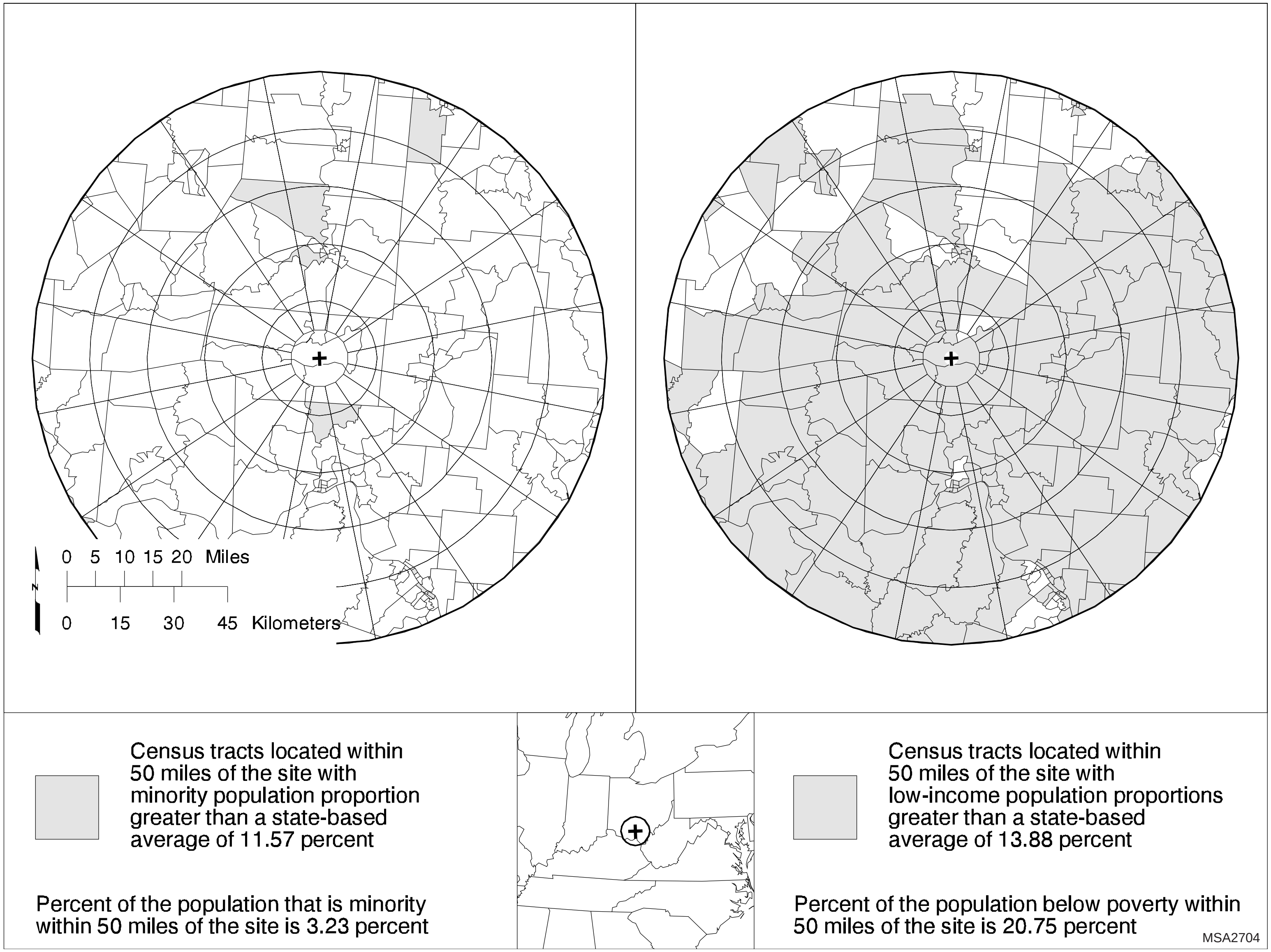

FIGURE 2.4 Distribution of Minority and Low-Income Census Tracts within a 50-Mile Radius of the Portsmouth Site

The proportion thresholds for determining the low-income and/or minority status of a census tract were based on the proportion of low-income and minority populations residing within the state of Ohio. If the 50-mile (80-km) radius around the site included a portion of another state or states, a weighted average based on all the affected state low-income and minority population proportions was assigned. Other reference threshold proportions were considered (i.e., national, multistate regional), but state population proportions were chosen because they tend to present a more accurate portrayal of the affected population. The population residing within a 50-mile (80-km) radius of the Portsmouth site was found to be composed of 3.2% minorities and 20.7% people with low incomes.

3 ENVIRONMENTAL IMPACTS OF CONTINUED CYLINDER STORAGE AT THE PORTSMOUTH SITE

Continued cylinder storage at the Portsmouth sites would be required for some period of time for all alternative management strategies. It was assumed that the entire depleted UF_6 cylinder inventory would continue to be stored at the Portsmouth site through 2008 for all alternatives. Under the no action alternative, the entire cylinder inventory would continue to be stored at the site indefinitely. For purposes of analysis and comparison with action alternatives, the assessment period considered was through the year 2039. Under the action alternatives, the number of cylinders stored at the site was assumed to decrease as the cylinders were transported to another location for conversion or long-term storage. This decrease was assumed to occur from 2009 through 2028.[1] The assessment of impacts from continued cylinder storage considers all anticipated activities required to safely manage the cylinder inventory from 1999 through 2039 for the no action alternative and from 1999 through 2028 for the action alternatives. Potential long-term impacts from cylinder breaches potentially occurring at the site through the year 2039 (no action alternative) or through 2028 (action alternatives) were estimated by calculating the maximum groundwater contamination levels possible in the future from those breaches.

Continued Storage of Cylinders

The continued storage of depleted UF_6 cylinders at the Portsmouth site would be required for some period of time for all alternative management strategies. Continued storage would involve maintenance of the cylinders — including inspections, painting, and cylinder yard upgrades — as well as valve replacement and cylinder repair, as needed. The impacts of continued storage at the Portsmouth site were assessed separately for the following:

No Action Alternative: Potential impacts were assessed for continued storage of the entire cylinder inventory at the Portsmouth site through the year 2039, including potential long-term impacts to groundwater and human health and safety.

Action Alternatives: Potential impacts were assessed for continued storage at the Portsmouth site based on the assumption that the number of cylinders at the site would begin to decrease in the year 2009 and that all of the cylinders would be removed by the end of the year 2028 (corresponding to the period during which conversion or long-term storage would be implemented). Potential long-term impacts were also assessed.

The cylinder surveillance and maintenance activities that are to be undertaken from now through September 30, 2002, are described in detail in the *UF_6 Cylinder Project Management Plan* (LMES 1997f). However, because the assessment period extends through

[1] These estimates were meant to provide a consistent analytical time frame for the evaluation of all the PEIS alternatives and do not represent a definitive schedule. When USEC-generated cylinders are considered, the timeframe for action alternatives extends to 2034 (see Sections 3.1 and 3.5).

the year 2039, a set of assumptions was needed to define the activities for estimating the impacts of continued storage through 2039. The assumptions used are documented in a memo by J.W. Parks, Assistant Manager for Enrichment Facilities, DOE Oak Ridge Operations Office (Parks 1997). In developing these assumptions, it was recognized that the activities actually undertaken might differ from those described in the cylinder project management plan. Therefore, assumptions were chosen such that anticipated impacts of continued cylinder storage made in the PEIS would result in conservative estimates (that is, the assumptions used would overestimate impacts rather than underestimate them).

Impacts associated with the following activities were analyzed: (1) storage yard reconstruction and cylinder relocations; (2) routine and ultrasonic testing inspections of cylinders and valve monitoring and maintenance; (3) cylinder painting; and (4) repair and removal of the contents of any cylinders that might be breached during the storage period. Although actual activities occurring at the site during the time period considered might vary from those described in the cylinder project management plan, the estimated impacts of continued storage activities assessed in this report are likely to encompass and bound the impacts. The assumptions for each activity are discussed further in the following paragraphs.

The inventory of depleted UF_6 cylinders generated by DOE before 1993 that is stored in two yards at the Portsmouth site is 13,388 cylinders (about 30% of the total inventory). An intensive effort is ongoing to improve yard storage conditions. This effort includes (1) relocation of some cylinders, which are currently either in contact with the ground or are too close to one another to allow for adequate inspections, and (2) construction of new storage yards or reconstruction of existing storage yards to provide a stabilized concrete base and monitored drainage for the cylinder storage areas.

The stored cylinders are regularly inspected for evidence of damage or accelerated corrosion; about 75% are inspected every 4 years, and 25% are inspected annually. Annual inspections are required for those cylinders that have been stored previously in substandard conditions and/or those that show areas of heavy pitting or corrosion. In addition to these routine inspections, ultrasonic inspections are currently conducted on some of the relocated cylinders. The ultrasonic testing is a nondestructive method to measure the wall thickness of cylinders. Valve monitoring and maintenance are also conducted for cylinders that exhibit discoloration of the valve or surrounding area during routine inspections. Leaking valves are replaced in the field. Impacts from routine inspections, ultrasonic inspections, and valve maintenance are evaluated as components of continued cylinder storage. For assessment of the no action alternative, the frequency of routine inspections and valve monitoring was assumed to remain constant through 2039, and ultrasonic testing was assumed to be conducted annually for 10% of the relocated cylinders. Relocation activities would be completed in about 2003, after which 10% of the cylinders painted each year were assumed to be inspected by ultrasonic testing. For the action alternatives, the frequency of inspections was assumed to decrease with decreasing cylinder inventory (about a 5% decrease in inspections per year) from 2009 through 2028.

Current plans call for cylinder painting to control cylinder corrosion. On the basis of information from the cylinder painting program (Pawel 1997), the analysis assumed that the paint would protect the cylinders for at least 10 years and that, once painted, the cylinders would not undergo further corrosion during that time. Although repainting might not actually be required every 10 years, the analysis assumed that every cylinder would be repainted every 10 years (except for the period 2019 through 2028 for the action alternatives, during which time no painting was assumed because of decreasing inventory size — i.e., cylinders being removed within 10 years for conversion or long-term storage elsewhere would not be repainted). The painting activity includes cylinder surface preparation (e.g., scraping and removal of rust deposits). Because some radioactive contaminants may exist on the surface of cylinders and because the metal content of the paints used previously are unknown, for purposes of analysis, the waste generated during surface preparation was considered to be low-level-mixed waste (i.e., hazardous waste plus low-level radioactive waste). Cylinder painting activities would be the primary source of potential radiological exposures for involved workers under the continued cylinder storage option.

Two breached cylinders have been identified at the Portsmouth site. Breached cylinders are cylinders that have a hole of any size at some location on the wall. Investigation of these breaches indicated that they were initiated by mechanical damage during stacking; the damage was not noticed immediately, and subsequent corrosion occurred at the damaged point. When cylinders are breached, moist air reacts with the exposed UF_6 and iron, resulting in the formation of a dense plug of uranium tetrafluoride (UF_4) and iron fluoride hydrates that prevents rapid loss of material from the cylinders, although slow corrosion continues. One breached cylinder that had been in storage for 13 years had an approximate hole size of 9 × 18 in. (23 × 46 cm); the mass of UF_6 lost from this cylinder was estimated to be between 17 and 109 lb (7.7 and 49 kg). The other breached cylinder had a hole 2 in. (5.1 cm) in diameter and had been in storage only 4 years; the mass of uranium lost from this cylinder was estimated to be less than 4 lb (1.8 kg). Further details on cylinder corrosion and releases due to breaches are given in Appendix B of the PEIS.

Considering the improved storage conditions in the yards, intensive inspection schedule, and the planned cylinder painting, the impact analysis for the no action alternative was based on the assumption that breaches resulting from corrosion would cease. Therefore, the primary potential cause of breaches considered for continued storage was mechanical damage occurring during cylinder handling (e.g., for painting or relocations). Although stringent inspection procedures are now in place to immediately identify and repair any cylinder breaches that might occur during handling, for purposes of analysis it was nonetheless assumed that breaches caused by mechanical damage would continue to occur at the same rate as in the past and that the breaches would go unidentified for a long enough time for releases to occur (see Appendix B of the PEIS). On the basis of these assumptions, the total numbers of breaches assumed to occur from 1999 through 2039 for the no action alternative analyses (base case) was 16 for the Portsmouth site (Table 3.1).

TABLE 3.1 Estimated Number of Breaches and Releases from 13,388 DOE-Generated Cylinders at the Portsmouth Site from 1999 through 2039, Assuming Control of External Corrosion by Painting[a]

Year of Breach	Number of Breaches[b]	Number of Active Breaches[c]	HF Emissions[d] (kg/yr)	Year of Breach	Number of Breaches[b]	Number of Active Breaches[c]	HF Emissions[d] (kg/yr)
1999	0	0	0	2020	0	1	2
2000	2	2	4	2021	1	2	4
2001	0	2	4	2022	0	1	2
2002	1	3	6	2023	0	1	2
2003	0	3	6	2024	1	2	4
2004	0	1	2	2025	0	1	2
2005	1	2	4	2026	1	2	4
2006	0	1	2	2027	0	2	4
2007	0	1	2	2028	0	1	2
2008	1	2	4	2029	1	2	4
2009	0	1	2	2030	0	1	2
2010	1	2	4	2031	0	1	2
2011	0	2	4	2032	1	2	4
2012	0	1	2	2033	0	1	2
2013	1	2	4	2034	1	2	4
2014	0	1	2	2035	0	2	4
2015	0	1	2	2036	0	1	2
2016	1	2	4	2037	1	2	4
2017	0	1	2	2038	0	1	2
2018	1	2	4	2039	0	1	2
2019	0	2	4	Total	16		

[a] PEIS analyses were conducted for the period 1999 through 2039. Existing models also predicted one possible breach due to handling in 1998.

[b] Estimates based on the assumption that a painting program would be effective in eliminating external corrosion by the year 2009. Breaches prior to 2009 were calculated as the sum of corrosion-initiated breaches for the proportion left unpainted in each year (based on external corrosion statistical model [Lyon 1996, 1997]) plus the handling-initiated breaches. For 2009-2039, only handling-initiated breaches were assumed. The breaches were assumed to go undetected for 4 years; in practice, improved storage conditions and maintenance and inspection procedures should prevent any breaches from occurring or going undetected for long periods.

[c] Number of active breaches = sum of current-year breaches and previous-3-year breaches, based on 4-year inspection intervals. Annual uranium emissions (lb/yr) = number of active breaches in that year (1 lb per active breach per year).

[d] Annual HF emissions (kg/yr) = number of active breaches × 0.0055 kg per breached cylinder per day × 365 days per year.

The above breach number was used to estimate potential impacts from repairing breached cylinders and from releases that might occur during continued storage through 2039 under the no action alternative. Potential radiological exposures of involved workers could result from patching breached cylinders and subsequently emptying the cylinder contents into new cylinders. The impacts to groundwater and human health and safety from uranium releases were assessed by estimating the amount of uranium that could be transported from the yards in surface runoff, followed by estimating migration through the soil to the groundwater.

The uncertainty in both the effectiveness of painting in controlling further corrosion and in the future painting schedule was addressed by also conducting a conservative assessment based on the assumption that external corrosion would not be halted by improved storage conditions and painting, resulting in more breaches (see Section 3.3). On the basis of these assumptions, the total number of breaches estimated from 1999 through 2039 was 74 for the Portsmouth site (Table 3.2). The results of this assessment were used to provide an estimate of the earliest time when continued cylinder storage could begin to raise regulatory concerns under these worst-case conditions.

For the action alternatives, continued storage would occur through 2028, with the inventory decreasing by about 5% per year starting in 2009 until no cylinders would remain at the site in 2028. Because the status of a cylinder painting program is less certain for the action alternatives, the estimated number of breached cylinders for these alternatives was based on the assumption that external corrosion was not controlled by painting (see Section 3.4 for a discussion of the potential impacts for the action alternatives).

For all hypothetical cylinder breaches, it was assumed that the breach would go undetected for a period of 4 years, which is the duration between planned inspections for most of the cylinders. In practice, cylinders that show evidence of damage or heavy external corrosion are inspected annually, so it is unlikely that a breach would go undetected for a 4-year period. On the basis of estimates from investigation of cylinder breaches that have occurred to date, 1 lb (0.45 kg) of uranium (in the form of uranyl fluoride [UO_2F_2]) and 4.4 lb (2 kg) of HF were assumed to be released from each breached cylinder annually for a period of 4 years (see Tables 3.1 and 3.2).

3.1 SUMMARY OF CONTINUED CYLINDER STORAGE IMPACTS

This section provides a summary of the potential environmental impacts associated with continued cylinder storage at the Portsmouth site for the no action alternative and for the action alternatives. Additional discussion and details related to the assessment methodologies and results for each area of impact are provided in Sections 3.2, 3.4, and 3.5.

After the draft PEIS was completed, management responsibility for approximately 2,700 additional cylinders of depleted UF_6 at the Portsmouth site was transferred from USEC to

TABLE 3.2 Estimated Number of Breaches and Releases from 13,388 DOE-Generated Cylinders at the Portsmouth Site from 1999 through 2039, Assuming Historical Corrosion Rates

Year of Breach	Number of Breaches[a]	Number of Active Breaches[b]	HF Emissions[c] (kg/yr)	Year of Breach	Number of Breaches[a]	Number of Active Breaches[b]	HF Emissions[c] (kg/yr)
1999	0	0	0	2020	2	6	12
2000	1	1	2	2021	1	5	10
2001	1	2	4	2022	2	6	12
2002	0	2	4	2023	2	7	14
2003	0	2	4	2024	2	7	14
2004	1	2	4	2025	2	8	16
2005	1	2	4	2026	2	8	16
2006	1	3	6	2027	2	8	16
2007	1	4	8	2028	3	9	18
2008	1	4	8	2029	3	10	20
2009	0	3	6	2030	2	10	20
2010	1	3	6	2031	3	11	22
2011	1	3	6	2032	4	12	24
2012	0	2	4	2033	3	12	24
2013	1	3	6	2034	3	13	26
2014	1	3	6	2035	4	14	28
2015	1	3	6	2036	4	14	28
2016	1	4	8	2037	4	15	30
2017	2	5	10	2038	4	16	32
2018	1	5	10	2039	5	17	34
2019	1	5	10	Total	74		

[a] These estimates are conservative estimates used for assessing potential impacts based on an external corrosion statistical model (Lyon 1996, 1997). The estimates were based on the assumption that historical corrosion rates would continue through 2039 (i.e., that corrosion would not have been eliminated by painting and maintenance). In practice, painting of cylinders, improved storage conditions, and maintenance and inspection procedures should prevent any breaches from occurring or from going undetected for long periods.

[b] Number of active breaches = sum of current-year breaches and previous-3-year breaches, based on 4-year inspection intervals. Annual uranium emissions (lb/yr) = number of active breaches in that year (1 lb per active breach per year).

[c] Annual HF emissions (kg/yr) = number of active breaches × 0.0055 kg per breached cylinder per day × 365 days per year.

DOE. To account for uncertainties associated with the number of cylinders that would be transferred from USEC to DOE in the future and to provide a bounding analysis of environmental impacts, the final PEIS evaluated the environmental impacts of managing an addition 3,000 cylinders at the Portsmouth site. The impacts associated with continued cylinder storage of the total cylinder inventory (including USEC-generated cylinders) under both the no action alternative and the action alternatives are discussed in Section 3.5. A summary of the estimated environmental impacts associated with continued storage of the DOE-generated cylinders only and of the total cylinder inventory (DOE-generated plus USEC-generated) is presented in Table 3.3 and the following text:

- Through the year 2039 for the no action alternative and the year 2034 for the action alternatives, all health and safety impacts to workers and the general public in the vicinity of the site as a result of cylinder storage and maintenance activities are estimated to be well within the applicable health and safety standards.

- All postulated accidents, including the highest consequence accidents, were estimated to result in zero latent cancer fatalities (LCFs) due to radiological causes among both workers and members of the general public. Some accidents, if they occurred, could result in up to 110 irreversible adverse effects among workers and 1 irreversible adverse effect among the general public due to chemical effects of released materials. However, such accidents have a very low probability and would not be expected to occur through the year 2039 for the no action alternative and the year 2034 for the action alternatives.

- During the assessment period (through 2039 under the no action alternative and 2034 under the action alternatives), all environmental impacts resulting from continued storage activities, including impacts to air resources, water resources, socioeconomics, ecological resources, waste management, land and other resources, cultural resources, and the environmental justice impacts would be negligibly small or well within the applicable standards.

- Long-term impacts from cylinder breaches estimated to occur through 2039 under the no action alternative would be well within the applicable standards assuming that cylinder painting would be effective in controlling corrosion. If no credit were taken for corrosion reduction through painting and continued maintenance, and on the basis of conservative estimates of numbers of breaches and material loss from breached cylinders, it is estimated that the uranium concentrations in the groundwater around the site would exceed the

TABLE 3.3 Summary of Continued Cylinder Storage Impacts at the Portsmouth Site[a]

No Action Alternative		Action Alternatives	
Impacts during Storage (1999–2039)	Long-Term Impacts	Impacts during Storage (1999–2028)	Long-Term Impacts
Human Health – Normal Operations: Radiological			
Involved Workers: Total collective dose: 380 person-rem [460 person-rem] Total number of LCFs (3 sites): 0.2 LCF	**Involved Workers:** No impacts	**Involved Workers:** Total collective dose: 180 person-rem [220 person-rem] Total number of LCFs: 0.07 LCF [0.09 LCF]	**Involved Workers:** No impacts
Noninvolved Workers: Maximum annual dose to MEI : 0.04 mrem/yr [0.05 mrem/yr) Maximum annual cancer risk to MEI: 2×10^{-8} per year Total collective dose 0.013 person-rem [0.016 person-rem] Total number of LCFs (3 sites): 5×10^{-6} LCF [6×10^{-6} LCF]	**Noninvolved Workers:** No impacts	**Noninvolved Workers:** Maximum annual dose to MEI : 0.06 mrem/yr [0.07 mrem/yr] Maximum annual cancer risk to MEI: 2×10^{-8} per year [3×10^{-8} per year] Total collective dose: 0.012 person-rem [0.015 person-rem] Total number of LCFs: 5×10^{-6} per year [6×10^{-6} LCF]	**Noninvolved Workers:** No impacts
General Public: Maximum annual dose to MEI: 0.02 mrem/yr Maximum annual cancer risk to MEI: 1×10^{-8} per year Total collective dose to population within 50 miles (3 sites): 0.05 person-rem [0.06 person rem] Total number of LCFs in population within 50 miles (3 sites): 3×10^{-5} LCF	**General Public:** Maximum annual dose to MEI: 0.026 – 0.33 mrem/yr Maximum annual cancer risk to MEI: $1 \times 10^{-8} - 2 \times 10^{-7}$ per year Total collective dose to population within 50 miles: not determined Total number of LCFs in population within 50 miles: not determined	**General Public:** Maximum annual dose to MEI: 0.022 mrem/yr [0.027 mrem/yr] Maximum annual cancer risk to MEI: 1×10^{-8} per year Total collective dose to population within 50 miles: 0.05 person-rem [0.06 person-rem] Total number of LCFs in population within 50 miles (3 sites): 3×10^{-5} LCF	**General Public:** Maximum annual dose to MEI: 0.21 mrem/yr Maximum annual cancer risk to MEI: 1×10^{-7} per year Total collective dose to population within 50 miles: not determined Total number of LCFs in population within 50 miles: not determined

TABLE 3.3 (Cont.)

No Action Alternative		Action Alternatives	
Impacts during Storage (1999–2039)	Long-Term Impacts	Impacts during Storage (1999–2028)	Long-Term Impacts
Human Health – Normal Operations: Chemical			
Noninvolved Workers: No impacts **General Public:** No impacts	**Noninvolved Workers:** No impacts **General Public:** No impacts	**Noninvolved Workers:** No impacts **General Public:** No impacts	**Noninvolved Workers:** No impacts **General Public:** No impacts
Human Health – Accidents: Radiological			
Bounding accident: vehicle-induced fire, 3 full 48G cylinders;[b] bounding accident frequency: 1 in 10,000 years to 1 in 1 million years **Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 0.02 rem Risk of LCF to MEI: 8×10^{-6} Collective dose: 16 person-rem Number of LCFs: 6×10^{-3} **General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.01 rem Risk of LCF to MEI: 1×10^{-5} Collective dose to population within 50 miles: 32 person-rem Number of LCFs in population within 50 miles: 2×10^{-2}	No accidents	Bounding accident: vehicle-induced fire, 3 full 48G cylinders;[b] bounding accident frequency: 1 in 10,000 years to 1 in 1 million years **Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 0.02 rem Risk of LCF to MEI: 8×10^{-6} Collective dose: 16 person-rem Number of LCFs: 6×10^{-3} **General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.01 rem Risk of LCF to MEI: 1×10^{-5} Collective dose to population within 50 miles: 32 person-rem Number of LCFs in population within 50 miles: 2×10^{-2}	No accidents

TABLE 3.3 (Cont.)

No Action Alternative		Action Alternatives	
Impacts during Storage (1999–2039)	Long-Term Impacts	Impacts during Storage (1999–2028)	Long-Term Impacts
Human Health – Accidents: Chemical			
Bounding accident: vehicle-induced fire, 3 full 48G cylinders (high for adverse effects); corroded cylinder spill, wet conditions (high for irreversible adverse effects);[b] bounding accident frequency: 1 in 10,000 years to 1 in 1 million years (vehicle-induced fire); 1 in 100 to 1 in 10,000 (cylinder spill)	No accidents	Bounding accident: vehicle-induced fire, 3 full 48G cylinders (high for adverse effects); corroded cylinder spill, wet conditions (high for irreversible adverse effects);[b] bounding accident frequency: 1 in 10,000 years to 1 in 1 million years (vehicle-induced fire); 1 in 100 to 1 in 10,000 (cylinder spill)	No accidents
Noninvolved Workers: Bounding accident consequences (per occurrence):		**Noninvolved Workers:** Bounding accident consequences (per occurrence):	
Number of persons with potential for adverse effects: 1,000 persons		Number of persons with potential for adverse effects: 1,000 persons	
Number of persons with potential for irreversible adverse effects: 110 persons		Number of persons with potential for irreversible adverse effects: 110 persons	
General Public: Bounding accident consequences (per occurrence):		**General Public:** Bounding accident consequences (per occurrence):	
Number of persons with potential for adverse effects: 650 persons		Number of persons with potential for adverse effects: 650 persons	
Number of persons with potential for irreversible adverse effects: 1 person		Number of persons with potential for irreversible adverse effects: 1 person	

TABLE 3.3 (Cont.)

No Action Alternative		Action Alternatives	
Impacts during Storage (1999–2039)	Long-Term Impacts	Impacts during Storage (1999–2028)	Long-Term Impacts
	Human Health — Accidents: Physical Hazards		
Construction and Operations: **All Workers:** 0.03 fatalities [0.04 fatalities] 39 injuries [48 injuries]	No activities in the long term	**Construction and Operations:** **All Workers:** 0.02 fatalities [0.024 fatalities] 26 injuries [32 injuries]	No activities in the long term
	Air Quality		
Construction: No construction at the Portsmouth site **Operations:** Criteria pollutant impacts all below 0.1% of respective standards	No activities in the long term	**Construction:** No construction at the Portsmouth site **Operations:** Criteria pollutant impacts all below 0.1% of respective standards	No activities in the long term
	Water		
Construction: No construction at the Portsmouth site **Operations:** Negligible impacts to surface water and groundwater	Negligible impacts to surface water and groundwater in the long-term	**Construction:** No construction at the Portsmouth site **Operations:** Negligible impacts to surface water; negligible to minor impacts to groundwater	Negligible impacts to surface water and groundwater in the long-term
	Soil		
Construction: No construction at the Portsmouth site **Operations:** Negligible impacts	No activities in the long term	**Construction:** No construction at the Portsmouth site **Operations:** Negligible impacts	No activities in the long term

TABLE 3.3 (Cont.)

No Action Alternative		Action Alternatives	
Impacts during Storage (1999–2039)	Long-Term Impacts	Impacts during Storage (1999–2028)	Long-Term Impacts
Socioeconomics[c]			
Jobs: 20 per year over 40 years, operations [24 per year over 40 years, operations] **Income:** $0.6 million per year over 40 years, operations [$0.7 million over 40 years, operations] **Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public housing	No activities in the long term	**Jobs:** 20 per year over 40 years, operations [24 per year over 40 years, operations] **Income:** $0.5 million per year over 40 years, operations [$0.6 million per year over 40 years, operations] **Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public housing	No activities in the long term
Ecology			
Construction: No construction at the Portsmouth site **Operations:** Negligible impacts to vegetation and wildlife	Negligible impacts to vegetation and wildlife with long-term	**Construction:** No construction at the Portsmouth site **Operations:** Negligible impacts to vegetation and wildlife	Negligible impacts to vegetation and wildlife in the long-term
Waste Management			
Negligible impacts for the Portsmouth site; negligible impacts to regional or national waste management operations	No activities in the long term	Negligible impacts for the Portsmouth site; negligible impacts to regional or national waste management operations	No activities in the long term
Resource Requirements			
Negligible impacts from resource requirements (such as electricity or materials) on the local or national scale are expected	No activities in the long term	Negligible impacts from resource requirements (such as electricity or materials) on the local or national scale are expected	No activities in the long term

TABLE 3.3 (Cont.)

No Action Alternative		Action Alternatives	
Impacts during Storage (1999–2039)	Long-Term Impacts	Impacts during Storage (1999–2028)	Long-Term Impacts
	Land Use		
Negligible impacts	No activities in the long term	Negligible impacts	No activities in the long term
	Cultural Resources		
No impacts	No activities in the long term	No impacts	No activities in the long term
	Environmental Justice		
No disproportionate impacts	No activities in the long term	No disproportionate impacts	No activities in the long term

[a] Under the no action alternative, continued storage of the cylinder inventory would take place at the Portsmouth site; under the action alternatives, the number of cylinders stored would decrease by 5% annually from 2009 through 2028. Under all alternatives, potential long-term impacts were evaluated for uranium contamination of soil and groundwater from cylinder breaches through 2028 or 2039. In general, the overall environmental consequences from managing the total cylinder inventory (total of DOE-generated and USEC-generated cylinders) are the same as those from managing the DOE cylinders only. In this table, when the consequences for the total inventory differ from those for the DOE-generated cylinders only, the consequences for the total inventory are presented in brackets following the consequences for DOE-cylinders only. HF = hydrogen fluoride, LCF = latent cancer fatality, MEI = maximally exposed individual, PM_{10} = particulate matter with a mean diameter of 10 :m or less, ROI = region of influence.

[b] The bounding radiological accident was defined as the accident that would result in the highest dose and risk to the general public MEI; the bounding chemical accident was defined as the accident that would result in the highest population risk (number of people affected).

[c] Direct jobs and income are presented for the peak year of construction and the peak year of operations. See Sections 3.2.5 and 3.4.5 for details on indirect impacts in the Portsmouth site ROI.

guideline of 20 μg/L used for comparison at some time in the future (around the year 2100 or later). For the action alternatives, all long-term impacts are estimated to remain within the guideline values with or without taking credit for reduced corrosion through painting.

3.2 POTENTIAL IMPACTS OF CONTINUED CYLINDER STORAGE FOR THE NO ACTION ALTERNATIVE

The potential environmental impacts from continued cylinder storage for the no action alternative were evaluated on the basis of activities that were assumed to be required to ensure safe storage of the cylinders (Parks 1997). These activities include routine and ultrasonic inspections of cylinders, valve maintenance, cylinder painting, storage yard reconstruction, and cylinder relocations. Although these activities would minimize the occurrence of cylinder breaches and would aid in the early identification of breached cylinders, the impacts associated with cylinder breaches that might occur during continued storage were nevertheless assessed. The assessment methodologies are described in Appendix C of the PEIS.

Assumptions for continued storage were generally selected in a manner intended to produce conservative estimates of impact, that is, the assumptions result in an overestimate of the expected impact. Therefore, although actual activities occurring at the site during the time period considered might vary, the estimated impacts of continued storage activities assessed are likely to encompass and bound the impacts that could occur. The following general assumptions apply to continued cylinder storage for the no action alternative:

- The current inventory of cylinders at the site would be maintained through the year 2039.

- The number of breaches assumed to occur under the no action alternative accounts for continued external corrosion prior to the completion of painting of the cylinder inventory. After painting, external corrosion was assumed to cease. Estimated numbers of breaches initiated by mechanical damage caused during cylinder handling are also included. Although current maintenance procedures would most likely lead to immediate identification and repair of any cylinder breaches, some releases of uranium and HF from breached cylinders were assumed for assessment purposes. Impacts were assessed for workers handling the breached cylinders, as well as for noninvolved workers and members of the general public exposed to materials released from breached cylinders.

- To assess potential long-term impacts to groundwater and human health and safety from breached cylinders, potential future groundwater contamination was assessed by assuming that released uranium would be transported from the cylinder storage yards in surface runoff and then migrate through the soil and into groundwater. It was further assumed that public access would be possible for groundwater at the location of the nearest discharge point (i.e., the nearest surface water body in the direction of groundwater flow).

- To address uncertainty in corrosion and cylinder breach assumptions, an assessment was also conducted assuming that external corrosion was not halted by improved maintenance conditions (see Section 3.3 for a discussion of potential impacts).

3.2.1 Human Health — Normal Operations

3.2.1.1 Radiological Impacts

Radiological impacts from normal operations of the Portsmouth cylinder storage yards were assessed for the involved workers, noninvolved workers, and off-site general public. Radiation exposures of involved workers would result primarily from external radiation from inspecting and handling the cylinders. Exposures of noninvolved workers would result from airborne releases of UO_2F_2 from breached cylinders. In addition to exposures from airborne releases of UO_2F_2, the analysis also considered potential exposures of the off-site public to waterborne releases of UO_2F_2. Such releases would be possible if UO_2F_2 was deposited on the ground surface and washed off by rain to a surface water body or infiltrated with rain to the deeper soil, thereby reaching the groundwater underlying the storage yards. Detailed discussions of the methodologies used in radiological impact analyses are provided in Appendix C of the PEIS and Cheng et al. (1997).

The estimated radiation doses and latent cancer risks are provided in Tables 3.4 and 3.5, respectively. During the storage periods, average radiation exposures of involved workers would be about 600 mrem/yr; exposures of noninvolved workers and members of the general public would be less than 1 mrem/yr. The long-term effects of radiation exposure on the general public resulting from groundwater contamination would be less than 1 mrem/yr. Potential long-term radiological impacts (based on groundwater contamination) are provided in Table 3.6.

The average annual collective worker dose would be 9.2 person-rem/yr for about 16 workers for the period from 1999 through 2039. The average individual worker dose would be about 600 mrem/yr for this operational period, which is below the regulatory limit of 5,000 mrem/yr and the DOE administrative control limit of 2,000 mrem/yr. The estimated average worker dose is

TABLE 3.4 Radiological Doses from Continued Cylinder Storage at the Portsmouth Site under Normal Operations under the No Action Alternative

Annual Dose to Receptor					
Involved Workers[a]		Noninvolved Workers[b]		General Public	
Average Individual Dose (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose[c] (mrem/yr)	Collective Dose[d] (person-rem/yr)	MEI Dose[e] (mrem/yr)	Collective Dose[f] (person-rem/yr)
600	9.2	0.043	0.00031	0.012 (< 0.0077)	0.0013

[a] Involved workers are those workers directly involved with the handling of materials. Impacts are presented as average individual dose and collective dose for the worker population. The reported values are averages over the time period 1999-2039. Radiation doses to individual workers would be monitored by a dosimetry program and maintained below applicable standards, such as the DOE administrative control limit of 2,000 mrem/yr.

[b] Noninvolved workers are individuals who work on-site but not within the cylinder storage yards. Exposures of noninvolved workers would result from airborne emissions of UO_2F_2 due to hypothetically breached cylinders. The exposure pathways considered included inhalation, external radiation, and incidental ingestion of soil.

[c] The MEI for the noninvolved workers was assumed to be at the on-site (outside storage yards) location that would yield the largest dose. The reported values are the maximums over the time period considered.

[d] The reported collective doses are averages over the time periods considered. The size of the population of noninvolved workers was assumed to be about 2,700 for Portsmouth.

[e] The MEI for the general public was assumed to be located off-site at a point that would yield the largest dose. The reported values are the maximums over the time period considered and are the results of exposures from inhalation, external radiation, and ingestion of plant foods, meat, milk, soil (all consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders and from drinking surface water (consequence of discharge of contaminated runoff water to a surface water body). Values within parentheses are the potential maximum doses from using contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock.

[f] Collective dose was estimated for the population within a radius of 50 miles (80 km) around the site. The reported values are averages over the time period considered. The off-site population is 605,000 for Portsmouth. Exposure pathways considered were inhalation, external radiation, and ingestion of plant foods, meat, milk, and soil (consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders.

TABLE 3.5 Latent Cancer Risks from Continued Cylinder Storage at the Portsmouth Site under Normal Operations under the No Action Alternative

Annual Risk of Latent Cancer Fatality to Receptor					
Involved Worker[a]		Noninvolved Worker[b]		General Public	
Average Individual Risk (risk/yr)	Collective Risk (fatalities/yr)	MEI Risk[c] (risk/yr)	Collective Risk[d] (fatalities/yr)	MEI Risk[e] (risk/yr)	Collective Risk[f] (fatalities/yr)
2×10^{-4}	4×10^{-3}	2×10^{-8}	1×10^{-7}	6×10^{-9} ($< 8 \times 10^{-10}$)	6×10^{-7}

[a] Involved workers are those workers directly involved with the handling of materials. Impacts are presented as average individual risk and collective risk for the worker population. The reported values are averages over the time period 1999–2039.

[b] Noninvolved workers are individuals who work on-site but not within the cylinder storage yards. Exposures of noninvolved workers would result from airborne emissions of UO_2F_2 due to hypothetically breached cylinders. The exposure pathways considered included inhalation, external radiation, and incidental ingestion of soil.

[c] The MEI for the noninvolved workers was assumed to be at the on-site (outside storage yards) location that would yield the largest risk. The reported values are the maximums over the time period considered.

[d] The reported collective risks are averages over the time period considered. The size of the population of noninvolved workers was assumed to be about 2,700 for Portsmouth.

[e] The MEI for the general public was assumed to be located off-site at a point that would yield the largest risk. The reported values are the maximums over the time period considered and are the results of exposures from inhalation, external radiation, and ingestion of plant foods, meat, milk, soil (all consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders and from drinking surface water (consequence of discharge of contaminated runoff water to a surface water body). Values within parentheses are the potential maximum doses from using contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock.

[f] Collective risk was estimated for the population within a radius of 50 miles (80 km) around the site. The reported values are averages over the time period considered. The off-site populations is 605,000 for Portsmouth. Exposure pathways considered were inhalation, external radiation, and ingestion of plant foods, meat, milk, and soil (consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders.

greater than the historical data of 55 to 196 mrem/yr (Hodges 1996) because of the more vigorous inspection and maintenance activities planned to be implemented. The radiation dose to noninvolved workers from airborne release of UO_2F_2 would be less than 0.043 mrem/yr for all periods.

The radiation dose to the maximally exposed member of the public would be less than 0.02 mrem/yr (0.012 mrem/yr from airborne releases plus 0.0077 mrem/yr from using contaminated groundwater), considerably below the regulatory limit of 10 mrem/yr from airborne emissions and 100 mrem/yr from all exposure pathways. The radiation dose from drinking contaminated surface water would be 2.1×10^{-5} mrem/yr. Compared with the existing exposure from operations for the entire Portsmouth site (0.066 mrem/yr; LMES 1996), the dose to the MEI from continued storage activities would be smaller. The long-term radiological impacts to the general public from using contaminated groundwater would range from 0.026 to 0.33 mrem/yr — depending on the soil properties, which would determine the time it took for the uranium to reach the groundwater.

TABLE 3.6 Long-Term Radiological Impacts to Human Health from Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative[a,b]

Impact to MEI of General Public	
Radiation Dose[c] (mrem/yr)	Latent Cancer Risk[c] (risk/yr)
0.026 – 0.33	$1 \times 10^{-8} - 2 \times 10^{-7}$

[a] The long-term impacts correspond to the time after the year 2039.

[b] Long-term impacts would be caused by the potential use of contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock. Contamination of groundwater would result from releases from hypothetically breached cylinders and the resulting infiltration of UO_2F_2 to the deeper soils, eventually reaching the groundwater (UO_2F_2 is the product of UF_6 reacting with moisture in air).

[c] Radiation doses and latent cancer risks are expressed as ranges, which would result from different transport speeds of uranium in soil. The reported values are the maximum values that would occur after 2039, assuming no mitigation action was taken.

3.2.1.2 Chemical Impacts

Chemical impacts during continued cylinder storage could result primarily from exposure to UO_2F_2 (the product formed when UF_6 is exposed to moist air) and HF released from hypothetical cylinder breaches. Risks from normal operations were quantified on the basis of calculated hazard indexes. Detailed discussions of the exposure assumptions, health effects assumptions, reference doses used for uranium compounds and HF, and calculational methods used in the chemical impact analysis are provided in Appendix C of the PEIS and Cheng et al. (1997).

Hazardous chemical impacts to the MEI were calculated for both noninvolved workers and members of the general public; the results are summarized in Table 3.7. Chemical exposures of noninvolved workers and the off-site general public could result from airborne emissions of UO_2F_2

TABLE 3.7 Chemical Impacts to Human Health from Continued Cylinder Storage at the Portsmouth Site under Normal Operations for the No Action Alternative

	Impact to Receptor			
	Noninvolved Workers[a]		General Public[b]	
Time Period	Hazard Index[c] for MEI	Population Risk[d] (ind. at risk/yr)	Hazard Index[c] for MEI	Population Risk[d] (ind. at risk/yr)
1999–2039	4.4×10^{-5}	–	2.6×10^{-3} (# 9.7×10^{-4})	–
Long term[e]	NA[f]	–	0.003 – 0.04	–

[a] Noninvolved workers are individuals who work on-site but not within the cylinder storage yards. The MEI for the noninvolved worker was assumed to be at the on-site (outside storage yards) location that would yield the largest exposure. Exposures would result from airborne emissions of UO_2F_2 and HF from hypothetically breached cylinders; the exposure pathways considered included inhalation and incidental ingestion of soil.

[b] The MEI for the general public was assumed to be located off-site at the point that would yield the largest exposure. Results reported are the maximum values over the time period considered and would result from exposure via inhalation; ingestion of soil (resulting from airborne emissions of UO_2F_2 and HF from hypothetically breached cylinders); and drinking surface water (consequence of the discharge of contaminated runoff water to a surface water body). Potential impacts during the storage period 1999–2039 (values within parentheses) were also evaluated from the use of contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock.

[c] The hazard index is an indicator for potential health effects other than cancer; a hazard index greater than 1 indicates a potential for adverse health effects and a need for further evaluation.

[d] Calculation of population risk is not applicable when the corresponding hazard index for the MEI is less than 1.

[e] Long-term impacts would result from using contaminated groundwater. Ranges result from different transport speeds of uranium in soil. The reported values are the maximum values that would occur after 2039, assuming no mitigative measures were taken.

[f] NA = not applicable; workers were assumed not to ingest groundwater.

and HF that could be dispersed from hypothetical cylinder breaches into the atmosphere and to the ground surface. The exposure pathways assessed included inhalation of UO_2F_2 and HF and ingestion of UO_2F_2 in soil. In all cases, the MEI hazard index would be considerably below 1, indicating no potential adverse health effects.

3.2.2 Human Health — Accident Conditions

A range of accidents covering the spectrum of high-frequency/low-consequence accidents to low-frequency/high-consequence accidents was presented in the SARs for the three storage sites (LMES 1997a-c). The potential accidents discussed in the SARs included natural phenomena events such as earthquakes, tornadoes, and floods, and spills from corroded cylinders under various weather conditions. The accidents selected for analysis for the PEIS and this report were those accident scenarios in the SARs that resulted in the greatest potential consequences for each of the four frequency categories (likely, unlikely, extremely unlikely, and incredible); these accidents are listed in Table 3.8. The accidents do not include natural phenomena events, which were found in the SARs to have less serious consequences than other types of accident scenarios (e.g., a vehicle-induced fire affecting three UF_6 cylinders). In those instances where it was not absolutely clear from the SAR which accident would be the bounding accident in a frequency category, several accidents were included in the analyses, as indicated in Table 3.8. The resulting radiological doses and adverse health impacts from chemical exposures for all the accidents listed in Table 3.8 are presented in Policastro et al. (1997). In the following sections, the results for only the bounding accident in each frequency category are presented. Detailed descriptions of the methodology and assumptions used in these calculations are provided in Appendix C of the PEIS and Policastro et al. (1997).

3.2.2.1 Radiological Impacts

Table 3.9 lists the radiological doses to various receptors for the accidents that give the highest dose from each frequency category. The LCF risks for these accidents are given in Table 3.10. The doses and the risks are presented for two different meteorological conditions (D and F stability classes)(see Appendix C of the PEIS). The doses and risks presented here were obtained by assuming that the accidents would occur. The probability of occurrence for each accident is indicated by the frequency category to which it belongs. For example, accidents in the extremely unlikely (EU) category have a probability of occurrence between 1 in 10,000 and 1 in 1 million in any 1 year. The following conclusions may be drawn from the radiological health impact results:

- No cancer fatalities would be predicted from any of the accidents.

- The maximum radiological dose to worker and general public MEIs (assuming that an accident occurred) would be 0.077 rem. This dose is less than the 25-rem dose recommended by the U.S. Nuclear Regulatory Commission (NRC 1994) for assessing the adequacy of protection of public health and safety from potential accidents.

- The overall radiological risk to worker and general public MEI receptors (estimated by multiplying the risk per occurrence [Table 3.10] by the annual probability of occurrence by the number of years of operations) would be less than 1 for all of the continued storage accidents.

TABLE 3.8 Accidents Considered for the Continued Storage Option at the Portsmouth Site

Site/Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in. deep water pool.	HF	150	60 (continuous)	Ground
Vehicle-induced fire, 3 full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground
Vehicle-induced fire, 3 full 48Y cylinders	Three full 48Y UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 18,000 2,770 8,010	0 to 24 24 24 to 30 30 to 236	Ground
Incredible Accidents (frequency: less than 1 in 1 million years)					
Small plane crash, 2 full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,190	0 to 30 30 to 121	Ground
Small plane crash, 2 full 48Y cylinders	A small plane crash affects two full 48Y UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 6,020 920 2,670	0 to 24 24 24 to 30 30 to 236	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	3,210 2,730	0 to 30 30 to 236	Ground

[a] Ground-level releases were assumed to occur outdoors on the concrete pads in the cylinder storage yards. To prevent contaminant migration, cleanup of residuals was assumed to begin immediately after the release was stopped.

TABLE 3.9 Estimated Radiological Doses per Accident Occurrence for Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative

		Maximum Dose[c]				Minimum Dose[c]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[a]	Frequency Category[b]	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)
Corroded cylinder spill, dry conditions	L	7.7×10^{-2}	2.2	2.2×10^{-3}	2.1×10^{-1}	3.3×10^{-3}	9.5×10^{-2}	9.3×10^{-5}	2.8×10^{-2}
Vehicle-induced fire, 3 full 48G cylinders	EU	2.0×10^{-2}	1.6×10^{1}	1.3×10^{-2}	3.2×10^{1}	3.7×10^{-3}	2.0	1.9×10^{-3}	1.6
Small plane crash, 2 full 48 G cylinders	I	6.6×10^{-3}	5.3	4.3×10^{-3}	5.5×10^{-1}	8.7×10^{-4}	6.9×10^{-1}	6.2×10^{-4}	7.6×10^{-2}

[a] The bounding accident chosen to represent each frequency category is the one that would result in the highest dose to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[b] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations ($>10^{-2}$/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations ($10^{-2} - 10^{-4}$/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} - 10^{-6}$/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations ($< 10^{-6}$/yr).

[c] Maximum and minimum doses reflect differences in assumed meteorological conditions at the time of the accident. In general, maximum doses would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum doses would occur under D stability with 4 m/s wind speed. An exception is the vehicle-induced fire involving 3 full 48G cylinders, which would result in a higher population dose for the general public under D stability with 4 m/s wind speed.

TABLE 3.10 Estimated Radiological Health Risks per Accident Occurrence for Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative[a]

		Maximum Risk[d] (LCFs)				Minimum Risk[d] (LCFs)			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[b]	Frequency Category[c]	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)
Corroded cylinder spill, dry conditions	L	3×10^{-5}	9×10^{-4}	1×10^{-6}	1×10^{-4}	1×10^{-6}	4×10^{-5}	5×10^{-8}	1×10^{-5}
Vehicle-induced fire, 3 full 48G cylinders	EU	8×10^{-6}	6×10^{-3}	6×10^{-6}	2×10^{-2}	1×10^{-6}	8×10^{-4}	1×10^{-6}	8×10^{-4}
Small plane crash, 2 full 48 G cylinders	I	3×10^{-6}	2×10^{-3}	2×10^{-6}	3×10^{-4}	3×10^{-7}	3×10^{-4}	3×10^{-7}	4×10^{-5}

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (LCF) times the estimated frequency times the number of years of operations (41 for the no action alternative). The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one that would result in the highest dose to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations ($>10^{-2}$/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations ($10^{-2} - 10^{-4}$/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} - 10^{-6}$/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations ($< 10^{-6}$/yr).

[d] Maximum and minimum doses reflect differences in assumed meteorological conditions at the time of the accident. In general, maximum doses would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum doses would occur under D stability with 4 m/s wind speed. An exception is the vehicle-induced fire involving 3 full 48G cylinders, which would result in a higher population dose for the general public under D stability with 4 m/s wind speed.

3.2.2.2 Chemical Impacts

The accidents discussed in this section are listed in Table 3.8. The results of the accident consequence modeling in terms of chemical impacts are presented in Tables 3.11 and 3.12. The results are presented as (1) number of persons with the potential for adverse effects and (2) number of persons with the potential for irreversible adverse effects. The tables present the results for the accident within each frequency category that would affect the largest number of people (total of workers and off-site population) (Policastro et al. 1997). The impacts presented are based on the assumption that the accidents would occur. The accidents listed in Tables 3.11 and 3.12 are not identical because an accident with the largest impacts for the adverse effects endpoint might not lead to the largest impacts for the irreversible adverse effects endpoint. Detailed descriptions of the methodology and assumptions for assessing chemical impacts are provided in Appendix C of the PEIS. The following conclusions may be drawn from the chemical impact results:

- If the accidents identified in Tables 3.11 and 3.12 did occur, the number of persons in the off-site population with the potential for adverse effects would range from 0 to 650 (maximum corresponding to the vehicle-induced fire scenario), and the number of off-site persons with potential for irreversible adverse effects would range from 0 to 1 (maximum corresponding to corroded cylinder spill scenarios).

- If the accidents identified in Tables 3.11 and 3.12 did occur, the number of noninvolved workers with the potential for adverse effects would range from 0 to 1,000 (maximum corresponding to the vehicle-induced fire scenario), and the number of noninvolved workers with the potential for irreversible adverse effects would range from 0 to 110 (maximum corresponding to the corroded cylinder spill with pooling scenario).

- Accidents resulting in a vehicle-induced fire involving three full 48G cylinders during very stable (nighttime) meteorological conditions would have a very low probability of occurrence but could affect a large number of people.

- The maximum risk was computed as the product of the consequence (number of people) times the frequency of occurrence (per year) times the number of years of operations (41 years, 1999–2039). The results indicate that the maximum risk values would be less than 1 for all accidents, except the following:

TABLE 3.11 Number of Persons with Potential for Adverse Effects from Accidents under Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative[a]

		Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[b]	Frequency Category[c]	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Corroded cylinder spill, dry conditions	L	Yes	48	Yes[f]	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	850	Yes	12	Yes	2	Yes[f]	0
Vehicle-induced fire, 3 full 48G cylinders	EU	Yes	1,000	Yes	650	Yes	160	Yes	4
Small plane crash, 2 full 48Y cylinders	I	Yes	760	Yes	6	No	0	No	0

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times the number of years of operations (41 for the no action alternative). The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU), 0.00001 = incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site people) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum risks reflect different meteorological conditions at the time of the accident. In general, maximum risks would occur under the meteorological condition of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either “Yes” or “No” for potential irreversible adverse effects to an individual.

[f] MEI locations were evaluated at 100 m from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the actual worker and general public population distributions were used, which did not show receptors at the MEI locations.

TABLE 3.12 Number of Persons with Potential for Irreversible Adverse Effects from Accidents under Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative[a]

		Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[b]	Frequency Category[c]	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Corroded cylinder spill, dry conditions[g]	L	Yes	0	No	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	90	Yes	1	Yes	0	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	110	Yes[f]	1	Yes	0	No	0
Small plane crash, 2 full 48Y cylinders[g]	I	No	0	No	0	No	0	No	0

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times the number of years of operations (41 for the no action alternative). The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site people) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum risks reflect different meteorological conditions at the time of the accident. In general, maximum risks would occur under the meteorological condition of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either “Yes” or “No” for potential irreversible adverse effects to an individual.

[f] MEI locations were evaluated at 100 m from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the actual worker and general public population distributions were used, which did not show receptors at the MEI locations.

[g] These accidents would result in the largest plume sizes, although no people would be affected.

- *Potential Adverse Effects:*

  Corroded cylinder spill, dry conditions (L, likely), workers

  Corroded cylinder spill, wet conditions – rain (U, unlikely), workers

- *Potential Irreversible Adverse Effects:*

  Corroded cylinder spill, wet conditions – rain (U, unlikely), workers

These risk values are conservative because the numbers of people affected were based on assuming (1) meteorological conditions that would result in the maximum reasonably foreseeable plume size (i.e., F stability and 1 m/s wind speed) and (2) wind in the direction that would lead to maximum numbers of individuals exposed for workers or for the general population.

To aid in the interpretation of accident analysis results, the number of fatalities potentially associated with the estimated potential irreversible adverse effects was estimated. All the bounding case accidents shown in Table 3.12 would involve releases of UF_6 and potential exposure to HF and uranium compounds. These exposures would likely be high enough to result in death for 1% or less of the persons experiencing irreversible adverse effects (Policastro et al. 1997). This would mean that for workers experiencing a range of 0 to 110 irreversible adverse effects, approximately 0 to 1 deaths would be expected. Similarly, of the general public experiencing a range of 0 to 1 irreversible adverse effects, less than 1 death would be expected. These are the maximum potential consequences of the accidents, the upper ends of the ranges assume worst-case weather conditions and that the wind would be blowing in the direction where the highest number of people would be exposed.

3.2.2.3 Physical Hazards

The risk of on-the-job fatalities and injuries for workers (involved and noninvolved) conducting activities associated with continued storage was calculated using industry-specific statistics from the U.S. Bureau of Labor Statistics, as reported by the National Safety Council (1995). Annual fatality and injury rates for manufacturing activities were used for all activities except cylinder yard construction or reconstruction; rates specific to construction were available for these activities. Injury incidence rates used were for injuries involving lost workdays (not including the day of injury).

The activities included as part of the continued storage strategy are routine cylinder inspections, ultrasonic inspections, valve monitoring and maintenance activities, cylinder relocations, cylinder yard construction or reconstruction, cylinder painting, and patching and content transfers for breached cylinders (Parks 1997). These activities were assumed to be continued at currently planned levels through the year 2039, except for yard construction and reconstruction, which were assumed to be completed by the year 2003. The annual labor requirements and the corresponding fatality and injury risks for these activities were estimated to be as follows: the fatality risk would be less than 1 (0.03), and the injury risk would be about 39 injuries.

3.2.3 Air Quality

The analysis of air quality impacts for continued cylinder storage under the no action alternative was based on three emissions-producing activities: (1) construction of new storage yards; (2) relocation and painting of cylinders; and (3) estimated HF emissions resulting from hypothetical cylinder breaches. The air quality impacts of these three activities at the Portsmouth site are addressed in this section. Additional details on the assessment of air quality impacts are presented in Tschanz (1997a,b).

No storage yard construction is planned for the Portsmouth site. The maximum criteria pollutant concentrations are shown in Table 3.13; criteria pollutant emissions for Portsmouth are associated with painting activities. For all pollutants, including PM_{10}, the concentrations are less than 0.1% of the standards. As shown in Table 3.14, the HF concentrations would likewise be small (Tschanz 1997b). The State of Ohio does not have an ambient air quality standard for HF.

No quantitative estimate was made of the impacts on the criteria pollutant ozone. Ozone formation is a regional issue affected by emissions data for the entire area around the Portsmouth site. Pike and Scioto Counties in the Wilmington-Chillicothe-Logan Air Quality Control Region are currently in attainment for all criteria pollutant standards, including ozone. The pollutant emissions most related to ozone formation that could result from continued cylinder storage at the Portsmouth site would be hydrocarbons (HC) and NO_x. The potential effects on ozone of those emissions can be put in perspective by comparing them with the total emissions of HC and NO_x for point sources in Pike and Scioto Counties, as recorded in the Ohio Environmental Protection Agency “Emissions Inventory” for 1990 (Juris 1996). The estimated HC and NO_x emissions of 3.01 and 0.05 tons/yr from continued storage actions would be only 0.18 and 0.002%, respectively, of the 1990 two-county emissions totals of those pollutants from inventoried point sources. These small additional contributions to the totals would be unlikely to alter the ozone attainment status of the region.

TABLE 3.13 Maximum Concentrations of Criteria Pollutants at Portsmouth Site Boundaries due to Cylinder Painting[a]

	Estimated Maximum Criteria Pollutants							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
Pollutant	Concentration (: g/m^3)	Fraction of Standard[b]	Concentration (: g/m^3)	Fraction of Standard[b]	Concentration (: g/m^3)	Fraction of Standard[b]	Concentration (: g/m^3)	Fraction of Standard[b]
CO	3.72	0.000093	0.583	0.000058	0.205	–	0.018	–
HC[c]	49.9	–	7.84	–	2.76	–	0.236	–
NO_x	0.445	–	0.070	–	0.025	–	0.0021	0.000021
SO_x	1.08	–	0.170	–	0.060	–	0.0051	0.000065
PM_{10}	0.097	–	0.015	–	0.0053	0.000035	0.00046	0.000092

[a] Maximum pollutant concentrations are based on the maximum number of cylinders painted annually under the no action alternative: 1,350 at Portsmouth. CO = carbon monoxide, HC = hydrocarbons, NO_x = nitrogen oxides, SO_x = sulfur oxides, PM_{10} = particulate matter with a mean diameter of 10 : m or less.

[b] Ratio of the upper end of the concentration range divided by the respective air quality standard. A ratio of less than 1 indicates that the standard would not be exceeded.

[c] HC, although not a criteria pollutant, was used to evaluate potential impacts to the criteria pollutant ozone.

TABLE 3.14 Estimated Number of Breached Cylinders, Maximum HF Emissions, and Average Maximum HF Concentrations at the Portsmouth Site under the No Action Alternative

Maximum Number of Breaches Starting in a Single Year	Maximum Total Number of Active Breaches in a Single Year	Maximum HF Concentration (: g/m^3) 24-Hour Average	Maximum HF Concentration (: g/m^3) Annual Average
2	3	0.10	0.011

3.2.4 Water and Soil

Potential water and soil impacts for continued storage of cylinders under the no action alternative were evaluated for surface water, groundwater, and soils at the Portsmouth site. Impacts to water and soil quality were evaluated by comparisons with EPA guidelines. Operational water use was estimated as ranging from 0.055 to 0.06 million gal/yr at Portsmouth.

3.2.4.1 Surface Water

The estimated number of cylinder breaches assumed to occur under the no action alternative is given in Table 3.1; this estimate was used to calculate potential impacts to surface water quality. Each breached cylinder was assumed to release a maximum of 4 lb (1.8 kg) of uranium over a period of 4 years; additional details on the methodology used to evaluate the impacts are given in Appendix C of the PEIS and Tomasko (1997b).

TABLE 3.15 Maximum Uranium Concentrations in Surface Waters for Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative

Receiving Water	Dilution Factor	Maximum Concentration (:g/L)
Little Beaver Creek	26	0.7
Scioto River	2,240	0.0004

The estimated maximum uranium concentrations in runoff water leaving the yards would be about 19 :g/L (5 pCi/L) for the Portsmouth site. This concentration would occur in about 2002. The contaminated runoff would then be assumed to flow without loss to the nearest surface water, where it would mix and be diluted. For average flow conditions, the dilution would be large enough that the maximum concentration would be less than 0.7 :g/L (0.2 pCi/L) (Table 3.15). This concentration is less than the EPA proposed drinking water maximum contaminant level (MCL) for uranium of 20 :g/L, used here for comparison. The contaminated water would then mix with water in the Scioto River, resulting in even greater dilution. Because of this mixing, impacts to the major rivers would not be measurable.

3.2.4.2 Groundwater

Groundwater impacts were assessed by assuming that water contaminated due to releases from hypothetical cylinder breaches would leave the yards as runoff and flow to the boundary of the nearest surface water (but not discharge to it), thereby creating a contaminated source on the ground surface. Under the no action alternative, the only impacts to groundwater would be to water quality; no impacts would occur to recharge, depth to water, or direction of flow (see Section 3.3 for discussion of potential impacts based on assuming a greater number of breaches). Conservative estimates of the concentration of uranium in groundwater were obtained by assuming the surface value to be equal to the maximum concentration in water leaving each yard during a time interval of approximately 40 years. This duration corresponds to the time period for the no action alternative. Details on the methodology are given in Appendix C of the PEIS and Tomasko (1997b).

At the end of the no action period (2039), the concentration of uranium in groundwater directly below the edge of the surface contamination at the Portsmouth site was estimated to be about 0.1 :g/L (Table 3.16), for a retardation factor of 5 (Tomasko 1997b). This concentration is less than

TABLE 3.16 Groundwater Concentrations for Continued Cylinder Storage at the Portsmouth Site for Two Soil Characteristics under the No Action Alternative[a]

	X = 0			X = 1,000 ft		
	Concentration		Time at Maximum Concentration	Concentration		Time at Maximum Concentration
Parameter	pCi/L	:g/L		pCi/L	:g/L	
Retardation Factor = 5						
Concentration at 40 years	0.03	0.10				
Maximum concentration	1	5.1	80 years	1.1	4.1	96 years
Retardation Factor = 50						
Maximum concentration	0.1	0.5	670 years	0.1	0.4	860 years

[a] Retardation factors describe how readily a contaminant such as uranium moves through the soil in groundwater. A retardation factor of 5 represents a case in which the uranium moves relatively rapidly in the soil; a retardation factor of 50 represents a case in which uranium moves slowly.

the EPA proposed drinking water MCL for uranium of 20 :g/L (EPA 1996). A maximum concentration of 5 :g/L would occur at the Portsmouth site around 2080 (Table 3.16). For a retardation factor of 50 (relatively immobile uranium transport), maximum concentrations would be about 10 times less.

3.2.4.3 Soil

The estimated number of cylinder breaches assumed to occur under the no action alternative was used to calculate impacts to soil quality. Each breached cylinder was assumed to release a maximum of 1 lb/yr (0.45 kg/yr) for a maximum of 4 years. For soil, the only impacts would be to quality; there would be no impacts to topography, permeability, or erosion potential. Details on these calculations and methodology are presented in Appendix C of the PEIS and Tomasko (1997b).

At the Portsmouth site, the highest soil concentration of uranium would be 0.09 :g/g in about 2002 for a distribution coefficient of 5 (relatively low sorption capacity). If the soil had a larger sorption capacity (K_d = 50), the maximum value would be 10 times greater, 0.9 :g/g. Even with the larger sorption, soil concentrations at the site would be below the recommended EPA guideline of 230 :g/g for residential soil and 6,100 :g/g for industrial soil (EPA 1995).

3.2.5 Socioeconomics

The impacts of continued storage on regional economic activity were estimated for an ROI around the Portsmouth site. Additional details regarding the assessment methodology are presented in Appendix C of the PEIS and Allison and Folga (1997).

Current storage activities at the site would likely have a small impact on socioeconomic conditions in the ROI surrounding the site (see Section 2.8 of this document). This is partly because a major proportion of expenditures associated with procurement for conducting continued storage activities would flow outside the ROI to other locations in the United States, thereby reducing the concentration of local economic effects of current storage activities at the site.

Slight changes in employment and income would occur in the ROI as a result of local spending derived from employee wages and salaries, local procurement of goods and services required to conduct continued storage activities, and other local investments associated with construction and operations. In addition to creating new (direct) jobs at the site, continued storage would also create indirect employment and income in the ROI as a result of jobs and procurement expenditures at the site. Jobs and income created directly by continued storage, together with indirect activity in the ROI, would contribute slightly to a reduction in unemployment in the ROI surrounding the site. Minimal impacts would be expected on local population growth and, consequently, on local housing markets and local fiscal conditions.

The effects of continued cylinder storage activities on regional economic activity, measured in terms of employment and personal income, and on population, housing, and local public revenues and expenditures at the Portsmouth site are discussed in this section. Impacts are presented for the peak year of construction and the peak year of operations. The potential impacts of continued cylinder storage at the site are shown in Table 3.17.

During the peak year of continued cylinder storage activities, 20 direct jobs would be created at the site and 10 additional jobs indirectly in the ROI (Table 3.17) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, 30 jobs would be created. Operations would also produce direct and indirect income in the ROI surrounding the site, at a total income of $0.7 million during the peak year. Continued cylinder storage operations would result in an increase of 0.001 percentage point in the projected baseline compound annual average growth rate in ROI employment from 1999 through 2039.

Continued cylinder storage activities would be expected to generate direct in-migration of less than 10 in the peak year (Table 3.17). Additional indirect job in-migration would also be expected and would bring the total number of in-migrants to 10 in the peak year. Operations would result in an increase of less than 0.001 percentage points in the projected baseline compound annual average growth rate in the ROI population from 1999 through 2039.

TABLE 3.17 Potential Socioeconomic Impacts of Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative[a]

Parameter	Impacts from Operations[b]
Economic activity in the ROI	
Direct jobs	20
Indirect jobs	10
Total jobs	30
Income ($ million)	
Direct income	0.6
Total income	0.7
Population in-migration into the ROI	10
Housing demand	
Number of units in the ROI	0
Public finances	
Change in ROI fiscal balance (%)	0.0

[a] There will be no impacts from construction, since no construction activities are planned for continued cylinder storage at the Portsmouth site.

[b] Impacts for peak year of operations. Duration of operations was assumed to be 41 years (1999–2039).

Continued cylinder storage activities would generate the demand for less than 10 additional rental housing units during the peak year of construction, thus representing an impact of 0.1% on the projected number of vacant rental housing units in the ROI (Table 3.17).

During the peak year of operations, 10 persons would in-migrate into the ROI, thereby leading to an increase that rounds to 0.0% over ROI-forecasted baseline revenues and expenditures (Table 3.17).

3.2.6 Ecology

Impacts to ecological resources during continued cylinder storage would be expected to be negligible. Analysis of potential impacts was based on exposure to airborne contaminants or contaminants released to soil, groundwater, or surface water. Predicted concentrations of contaminants in environmental media were compared to benchmark values of toxic and radiological effects to assess impacts to terrestrial and aquatic biota. A detailed discussion of assessment methodology is presented in Appendix C of the PEIS.

Atmospheric emissions of criteria pollutants from cylinder painting would be well below levels harmful to biota, and impacts to ecological resources would be negligible. (See Section 3.2.3 for a discussion of air quality impacts and Appendix C of the PEIS for application of predicted values.)

The maximum annual average air concentration of HF at the site boundary, due to hypothetical cylinder breaches, would be very low, about 0.011 : g/m^3. Resulting impacts to biota would be expected to be negligible. Potential impacts to ecological resources are shown in Table 3.18.

Soil near the storage yards could become contaminated with uranium by surface runoff from the yards. Uptake of uranium-containing compounds can cause adverse effects to vegetation. The potential maximum uranium concentration in soil would be 0.9 : g/g (Section 3.2.4.3). Because this estimated concentration is below the lowest concentration known to produce toxic effects in plants, toxic effects on vegetation due to uranium uptake would not be expected (Table 3.18).

TABLE 3.18 Potential Impacts to Ecological Resources from Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative

Contaminant	Biota	Maximum Exposure	Effect
Hydrogen fluoride	Wildlife	0.01 : g/m^3	Negligible
Uranium in surface water	Aquatic	19 : g/L	Negligible
		4.8 pCi/L	Negligible
Uranium in groundwater	Aquatic	5.1 : g/L	Negligible
		1 pCi/L	Negligible
Uranium in soil	Plants	0.9 : g/g	Negligible

Surface runoff from the storage yards would result in a maximum (undiluted) uranium concentration of 19 μg/L (4.8 pCi/L) at the Portsmouth site (Section 3.2.4.1). Resulting dose rates to maximally exposed organisms in the nearest receiving surface water body at each site would be negligible. This uranium concentration is also considerably below 150 μg/L, which is the lowest concentration known to adversely affect aquatic biota. Therefore, impacts to aquatic biota would not be expected.

Surface runoff from the storage yards could infiltrate adjacent soil and become a source of groundwater contamination. Groundwater could discharge to the surface (such as in wetland areas) near the facility, thus exposing biota to contaminants. Groundwater concentrations of uranium near the storage yards could range up to 5.1 μg/L at the Portsmouth site; uranium activity could range up to 1 pCi/L (Section 3.2.4.2). Resulting toxic effects and dose rates to maximally exposed organisms would be negligible. Resulting impacts to aquatic biota would therefore be negligible (Table 3.18).

Facility accidents (Section 3.2.2) could result in adverse impacts to ecological resources. The affected species and degree of impact would depend on a number of factors, such as location of the accident, season, and meteorological conditions.

3.2.7 Waste Management

The principal wastes expected to be generated by operations involving continued cylinder storage are LLW and LLMW. Impacts on waste management from wastes generated during the continued storage operations would be caused by the potential overload of waste treatment and/or disposal capabilities either at a site or on a regional/national scale. Total wastes generated at the site from continued cylinder storage under the no action alternative are listed in Table 3.19. Given the types and quantities of waste to be generated, there is little potential for impacts on regional or national waste treatment/disposal capabilities.

Only limited construction of additional facilities would be needed to support the operations involved in the continued storage and maintenance of cylinders. No waste management impacts resulting from construction-generated wastes would be expected.

TABLE 3.19 Waste Generated during Continued Cylinder Storage under the No Action Alternative (1999-2039)

Waste (m^3)	
LLW[a]	LLMW[b]
23	418

[a] Contaminated scrap metal from breached cylinders that would require emptying.

[b] Inorganic process residues from cylinder painting.

The normal operations to maintain and store cylinders would consist of inspections, stripping and repainting of the cylinders, and disposal of scrap metal from breached cylinders that required emptying. These operations would generate two primary waste streams (1) uranium-contaminated scrap metal LLW from breached cylinders and failed valves and (2) solid process residue LLMW from cylinder painting. In the event of cylinder failure, small amounts of additional LLMW could be generated due to releases from breached cylinders.

The amount of LLW generated from continued storage would represent, at most, less than 1% of site LLW generation (see Section 2.9). The maximum annual amount of LLW generated during the continued storage of cylinders would represent less than 1% of the annual DOE LLW generation.

Continued storage would also generate LLMW. Overall, the waste input resulting from continued cylinder storage would have negligible impacts on waste management capabilities at the Portsmouth sites. Impacts on national waste management capabilities would be negligible. The input of LLMW from continued cylinder storage at the site would represent less than 1% of the total nationwide LLMW load.

3.2.8 Resource Requirements

The approach taken to assess resource requirements was based on a comparison of required resources with national and state-level statistics on consumption of commodities (U.S. Department of Commerce 1997, 1999). More detailed information related to the methodology is presented in Appendix C of the PEIS.

Material resources that could be consumed during continued cylinder storage include construction materials that could not be recovered or recycled, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required could include concrete, sand, gravel, steel, and other metals. In general, none of the construction resources identified for continued cylinder storage are in short supply, and all would be readily available in the vicinity of the site. Energy resources during construction and operations would include the consumption of diesel fuel and gasoline for construction equipment and transportation vehicles. The anticipated utilities requirements would be within the supply capacities at each site.

No construction activities are anticipated at the Portsmouth site. Continued cylinder storage would require materials such as 55-gal drums for containment of any generated waste, replacement cylinder valves for those found to be defective upon inspection, and diesel fuel and gasoline to operate equipment and on-site vehicles. In addition, two gallons of paint per cylinder would be required for cylinder painting. Potable water would be made available for the needs of the workforce.

Materials and utilities required for construction and operating activities for continued storage at the Portsmouth site are presented in Table 3.20. The total quantities of commonly used construction materials are expected to be small compared to local sources. No strategic and critical materials are projected to be consumed for either construction or operations. Small amounts of diesel fuel and gasoline are projected to be used. The required material resources during operations would be readily available.

TABLE 3.20 Resource Requirements for Operations for Continued Cylinder Storage at the Portsmouth Site under the No Action Alternative[a]

Materials/Resource	Consumption during 1999–2039
Solids	
55-gal drums (each)	50
Cylinder valves (1 in.) (each)	4
Liquids (gal/yr)	
Gasoline	1,600 – 1,700[b]
Diesel fuel	4,100
Zinc-based paint	2,700

[a] There would be no requirements for construction, since no construction activities are planned for continued cylinder storage at the Portsmouth Site.

[b] Values reported as ranges generally correspond to varying resource requirements during years for which activities are planned.

3.2.9 Land Use

No construction activities are planned for the Portsmouth site. During continued cylinder storage operations, land-use impacts at the site would be negligible and limited to potential minor disruptions on land parcels contiguous to the existing yards. No impacts would be expected for off-site land use.

3.2.10 Cultural Resources

Impacts to cultural resources would not occur at the Portsmouth site during continued cylinder storage because no new storage yards are proposed.

3.2.11 Environmental Justice

The analysis of potential environmental justice impacts resulting from continued cylinder storage is based on the conclusions drawn in the assessment of impacts on human health (Sections 3.2.1 and 3.2.2) and a review of environmental impacts presented in discussions of other technical areas (Sections 3.2.3 through 3.2.10) such as air quality, water quality and soils, socioeconomics, and ecological resources. The analysis of health effects included an examination of risks to the general public associated with normal facility operations and accidents. A detailed description of the mapping procedures, screening criteria, calculational methods, and demographic sector analysis is presented in Appendix C, Section C.8, of the PEIS.

Events occurring after 2039 could not be included in the analysis of potential environmental justice impacts because the composition of the population residing within 50 miles (80 km) of a site cannot be projected with accuracy over the long term. Current minority and low-income population proportions for the site were assumed out to the year 2039.

A review of potential human health impacts (Sections 3.2.1 and 3.2.2) indicated that no high and adverse human health effects or impacts would be expected from continued storage of cylinders at the Portsmouth site. Therefore, although minority and low-income populations reside within 50 miles (80 km) of the site, no disproportionate impacts would be expected. The distributions of minority and low-income population census tracts within a 50-mile (80-km) radius of the site are shown in Figure 2.4. Screening criteria limits (Appendix C, Section C.8, of the PEIS) for radiological and chemical sources under normal operations and accident conditions were not exceeded, and the risk of fatalities from operations and accidents from 1999 through 2039 would be considerably below one. Radiological releases from normal operations at the site would result in annual average doses to the MEI residing outside the facilities that would be considerably below the DOE regulatory limit of 100 mrem/yr for members of the public. Chemical impacts from routine operations under continued storage at the site would result in MEI hazard indices well below 1. In addition, accidental chemical releases would not result in any expected fatalities or expected adverse human health effects for the general public (when considering risk, i.e., the product of the potential number of persons affected and the probability of the accident occurring).

A review of impact assessments for other technical areas (Sections 3.2.3 through 3.2.10) indicated that few or no impacts would be expected from continued storage of cylinders at any of the sites. Projected air emissions from construction activities and operations would be below federal and state regulatory limits and no impacts to water quality or soils are anticipated. Consequently, no segment of the population, including minorities or persons of low-income, would experience disproportionate impacts.

3.2.12 Other Impacts Considered But Not Analyzed in Detail

Other impacts that could potentially occur as a result of continued storage of depleted UF_6 cylinders at the site include impacts to the visual environment (e.g., aesthetics), recreational resources, and noise levels, as well as impacts associated with decontamination and decommissioning of the storage yards. These impacts, although considered, were not analyzed in detail because the impacts would be negligibly small or consideration of the impacts would not contribute to differentiation among the alternatives and therefore would not affect the decisions to be made in the Record of Decision to be issued following publication of the PEIS.

3.3 POTENTIAL IMPACTS OF CONTINUED CYLINDER STORAGE BASED ON UNCERTAINTIES IN CORROSION CONTROL

Under the no action alternative, it was assumed that cylinders would be painted every 10 years and that the paint would effectively stop any further corrosion of the cylinders (see introduction to Section 3). To address uncertainty in both the effectiveness of the painting in controlling further corrosion and uncertainties in the future painting schedule, a conservative assessment was made of the impacts assuming that painting would have no effect on corrosion. Under this assumption and using historical data, the number of breaches that would occur at the site as a function of time were estimated (Lyon 1997). These conservative estimates indicate that the number of breaches that could occur prior to 2039 would be about 74 at the Portsmouth site (see Table 3.2).

If no credit was taken for corrosion reduction through painting, and if storage was continued indefinitely, calculations indicate that uranium releases from breaches occurring at the Portsmouth site prior to about the year 2050 could result in a sufficient amount of uranium in the soil column, to bring the groundwater concentration of uranium to 20 µg/L in the future (about 2100) (Tomasko 1997a). The groundwater concentration would not actually reach 20 µg/L at the site until about 2100 or later.

Also, if no credit was taken for corrosion reduction through painting, it is possible that air quality concerns might arise. The maximum estimated 24-hour average HF concentration at the Portsmouth site boundary through the year 2039 would be 0.6 µg/m^3, considerably below the 2.9 µg/m^3 level (which is the primary standard for the State of Tennessee, used here for comparison). The State of Ohio does not have standards for HF.

A painting program for the cylinders, designed to control further corrosion, has been initiated at the site. Therefore, the assumption of uncontrolled corrosion is not a reasonable assumption. The painting program is expected to eliminate or substantially reduce the corrosion of cylinders at the site. DOE will continue to monitor its cylinders and is committed to maintain the safety basis of continued cylinder storage. If the conditions became substantially different from what is assumed under the no action alternative, DOE would take the appropriate action(s) to maintain the safety basis.

3.4 POTENTIAL IMPACTS OF CONTINUED CYLINDER STORAGE FOR THE ACTION ALTERNATIVES

For the action alternatives considered in the PEIS — long-term storage as UF_6, long-term storage as uranium oxide, use as uranium oxide, use as uranium metal, and disposal as uranium oxide — continued storage could be necessary for some portion of the DOE-generated cylinders at the current storage sites through approximately 2028 (through 2034 when USEC-generated cylinders are considered - see Section 3.5). This 30-year storage period would correspond to the period during which construction of conversion, long-term storage, and/or disposal facilities would occur and during which the cylinders would be transported from the current locations to the processing locations. For analyses in the PEIS, the cylinder removal period was assumed to take place between 2009 and 2028; the number of cylinders at each site would decrease by 5% annually during that time.

Potential environmental impacts associated with continued cylinder storage for the action alternatives were assessed with essentially the same methodology used to estimate impacts for the no action alternative (see Section 3.2 of this report and Appendix C of the PEIS). Through the year 2008, the number of maintenance activities (such as inspections, yard reconstruction, and painting) was assumed to be the same as for the no action alternative (Parks 1997). From 2009 through 2028, the number of maintenance activities was assumed to decrease by 5% annually, to correspond to the reduction in cylinder inventory that would be occurring. Impacts associated with maintenance activities (e.g., radiation doses to involved workers) would, therefore, generally be reduced for the action alternatives.

A key difference between the assessment of continued storage impacts for the action alternatives and the assessment conducted for the no action alternative was in the assumptions made regarding potential numbers of breached cylinders. Because of impending cylinder movement or content transfer, cylinder yard improvement and cylinder painting might not occur at the same rate under the action alternatives as they would under the no action alternative. Because the painting schedule that would be followed under the action alternatives is not known, and to present reasonable upper bound estimates of impacts, no credit was taken for the effectiveness of cylinder yard improvements and painting in reducing cylinder corrosion rates. Therefore, the number of hypothetical cylinder breaches assumed for the action alternatives was estimated by assuming that painting and improved storage conditions were not effective in arresting continued corrosion of the cylinders (i.e., assuming that corrosion continued at historical rates), and by assuming that the population of cylinders at the site was decreasing at an annual rate of 5% between the years 2009 and 2028. These assumptions led to a higher number of assumed breaches for continued storage under the action alternatives than under the no action alternative, even though the number of years of storage would be fewer. The assumptions for releases of uranium and HF from breached cylinders, as well as for methods to estimate water and soil impacts, were identical to those used for the assessment of impacts for the no action alternative. However, the outcome of the increased number of assumed cylinder breaches was a slightly higher estimate of impacts on groundwater, air quality, and human health and safety for the action alternatives, although the estimated impacts are still within applicable standards or guidelines (see Table 3.1). The impacts of continued cylinder storage under the action alternatives for the various technical areas of interest are discussed in Sections 3.4.1 through 3.4.11. Assessment methods are described in Appendix C of the depleted UF_6 PEIS.

3.4.1 Human Health — Normal Operations

3.4.1.1 Radiological Impacts

Estimated radiation doses and latent cancer risks for the site are presented in Tables 3.21 and 3.22. Long-term radiological impacts (based on groundwater contamination) are provided in Table 3.23.

During the continued cylinder storage period (1999–2028), the average annual collective dose for involved workers would be about 6 person-rem/yr for approximately 14 workers, assuming the workers work 5 hours per day in the cylinder yards. The individual dose for involved workers would average 450 mrem/yr. The doses for the MEIs of noninvolved workers and members of the general public would be less than 0.06 and 0.02 mrem/yr, respectively, from airborne emission of UO_2F_2. Additional exposure of the general public could be caused by use of contaminated groundwater; the maximal dose would be about 0.005 mrem/yr by the end of the cylinder storage period. The radiation exposure of involved workers would be much less than the regulatory limit of 5,000 mrem/yr; exposure of noninvolved workers and members of the general public would be quite small compared with the regulatory limits of 10 mrem/yr for airborne emissions and 100 mrem/yr for all exposure pathways for the general public.

Long-term radiation exposure after the year 2028 from the use of contaminated groundwater would result in a maximum dose of 0.21 mrem/yr.

3.4.1.2 Chemical Impacts

Chemical impacts associated with continued cylinder storage could result primarily from exposure to uranium compounds and HF released from hypothetical cylinder breaches. Estimated impacts for the site are given in Table 3.24. The highest hazard quotients result when the use of contaminated groundwater is considered in addition to exposures through inhalation, soil ingestion, and surface water ingestion (i.e., maximum hazard quotient of 0.03). Adverse health effects would not be expected from exposure to chemical contaminants associated with continued cylinder storage (that is, the estimated hazard indices would all be less than the threshold value of 1).

3.4.2 Human Health — Accident Conditions

The assessment of impacts conducted for potential accidents associated with continued cylinder storage under the action alternatives was similar to that for the no action alternative

TABLE 3.21 Radiological Doses from Continued Cylinder Storage under Normal Operations at the Portsmouth Site under the Action Alternatives

Annual Dose to Receptor					
Involved Workers[a]		Noninvolved Workers[b]		General Public	
Average Individual Dose (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose[c] (mrem/yr)	Collective Dose[d] (person-rem/yr)	MEI Dose[e] (mrem/yr)	Collective Dose[f] (person-rem/yr)
450	6.0	0.057	0.00040	0.017 (< 0.0051)	0.0017

[a] Involved workers are those workers directly involved with the handling of materials. Impacts are presented as average individual dose and collective dose for the worker population. The reported values are averages over the time period 1999-2028. Radiation doses to individual workers would be monitored by a dosimetry program and maintained below applicable standards, such as the DOE administrative control limit of 2,000 mrem/yr.

[b] Noninvolved workers are individuals who work on-site but not within the cylinder storage yards. Exposures of noninvolved workers would result from airborne emissions of UO_2F_2 due to hypothetically breached cylinders. The exposure pathways considered included inhalation, external radiation, and incidental ingestion of soil.

[c] The MEI for the noninvolved workers was assumed to be at the on-site (outside storage yards) location that would yield the largest dose. The reported values are the maximums over the time period considered.

[d] The reported collective doses are averages over the time periods considered. The size of the population of noninvolved workers was assumed to be about 2,700 for the Portsmouth site.

[e] The MEI for the general public was assumed to be located off-site at a point that would yield the largest dose. The reported values are the maximums over the time period considered and are the results of exposures from inhalation, external radiation, and ingestion of plant foods, meat, milk, soil (all consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders and from drinking surface water (consequence of discharge of contaminated runoff water to a surface water body). Values within parentheses are the potential maximum doses from using contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock.

[f] Collective dose was estimated for the population within a radius of 50 miles (80 km) around the site. The reported values are averages over the time period considered. The off-site population is 605,000 for Portsmouth. Exposure pathways considered were inhalation, external radiation, and ingestion of plant foods, meat, milk, and soil (consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders.

TABLE 3.22 Latent Cancer Risks from Continued Cylinder Storage under Normal Operations at the Portsmouth Site under the Action Alternatives

Annual Risk of Latent Cancer Fatality to Receptor					
Involved Worker[a]		Noninvolved Worker[b]		General Public	
Average Individual Risk (risk/yr)	Collective Risk (fatalities/yr)	MEI Risk[c] (risk/yr)	Collective Risk[d] (fatalities/yr)	MEI Risk[e] (risk/yr)	Collective Risk[f] (fatalities/yr)
2×10^{-4}	2×10^{-3}	2×10^{-8}	2×10^{-7}	8×10^{-9} ($< 5 \times 10^{-10}$)	8×10^{-7}

[a] Involved workers are those workers directly involved with the handling of materials. Impacts are presented as average individual risk and collective risk for the worker population. The reported values are averages over the time period 1999-2028.

[b] Noninvolved workers are individuals who work on-site but not within the cylinder storage yards. Exposures of noninvolved workers would result from airborne emissions of UO_2F_2 due to hypothetically breached cylinders. The exposure pathways considered included inhalation, external radiation, and incidental ingestion of soil.

[c] The MEI for the noninvolved workers was assumed to be at the on-site (outside storage yards) location that would yield the largest risk. The reported values are the maximums over the time period considered.

[d] The reported collective risks are averages over the time period considered. The size of the population of noninvolved workers was assumed to be about 2,700 for Portsmouth.

[e] The MEI for the general public was assumed to be located off-site at a point that would yield the largest risk. The reported values are the maximums over the time period considered and are the results of exposures from inhalation, external radiation, and ingestion of plant foods, meat, milk, soil (all consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders and from drinking surface water (consequence of discharge of contaminated runoff water to a surface water body). Values within parentheses are the potential maximum doses from using contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock.

[f] Collective risk was estimated for the population within a radius of 50 miles (80 km) around the site. The reported values are averages over the time period considered. The off-site population is 605,000 for Portsmouth. Exposure pathways considered were inhalation, external radiation, and ingestion of plant foods, meat, milk, and soil (consequences of airborne emissions of UO_2F_2) due to hypothetically breached cylinders.

(Section 3.2.2) in that the same accidents were considered and the consequences of those accidents would be the same. However, because the duration of continued cylinder storage under the action alternatives is 11 years shorter than that assessed for the no action alternative (i.e., 30 years assumed for the action alternatives compared with 41 years assumed for the no action alternative), the risk of these accidents occurring would therefore be somewhat lower under the action alternatives.

TABLE 3.23 Long-Term Radiological Impacts to Human Health from Continued Cylinder Storage at the Portsmouth Site under the Action Alternatives[a,b]

Impact to MEI of General Public	
Radiation Dose[c] (mrem/yr)	Latent Cancer Risk[c] (risk/yr)
0.021 – 0.21	$1 \times 10^{-8} – 1 \times 10^{-7}$

[a] Long-term impacts correspond to the time after the year 2028.

[b] Long-term impacts would be caused by the potential use of contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock. Contamination of groundwater would result from releases from hypothetically breached cylinders and the resulting infiltration of UO_2F_2 to the deeper soils, eventually reaching the groundwater (UO_2F_2 is the product of UF_6 reacting with moisture in air).

[c] Radiation doses and latent cancer risks are expressed as ranges, which would result from different transport speeds of uranium in soil. The reported values are the maximum values that would occur after 2028, assuming no mitigation action was taken.

3.4.2.1 Radiological Impacts

The accidents that might be associated with continued cylinder storage under the action alternatives are identical to those under the no action alternative. Section 3.2.2.1 discusses potential human health impacts associated with radiological exposures from accidental releases.

3.4.2.2 Chemical Impacts

The accidents that might be associated with continued cylinder storage under the action alternatives are identical to those addressed under the no action alternative. See Section 3.2.2.2 for the discussion of potential human health impacts associated with chemical exposures from accidental releases.

3.4.2.3 Physical Hazards

The activities considered in calculating the physical hazards associated with continued cylinder storage were routine cylinder inspections, ultrasonic inspections, valve monitoring and maintenance activities, cylinder relocations, cylinder painting, and patching and content transfers of breached cylinders. These activities were assumed to continue through the year 2039. The annual labor requirements and the corresponding fatality and injury risks to all workers for these activities were estimated to be as follows: the fatality incidence at the Portsmouth site would be 0.02, and the injury incidence would be about 26 injuries.

TABLE 3.24 Chemical Impacts to Human Health from Continued Cylinder Storage under Normal Operations at the Portsmouth Site under the Action Alternatives

	Impacts to Receptor			
	Noninvolved Workers[a]		General Public[b]	
Time Period	Hazard Index[c] for MEI	Population Risk[d] (ind. at risk/yr)	Hazard Index[c] for MEI	Population Risk[d] (ind. at risk/yr)
1999–2028	3.9×10^{-5}	–	3.0×10^{-3} (6.4×10^{-4})	–
Long term	NA[f]	–	0.003 – 0.03	–

[a] Noninvolved workers are individuals who work on-site but not within the cylinder storage yards. The MEI for the noninvolved worker was assumed to be at the on-site (outside storage yards) location that would yield the largest exposure. Exposures would result from airborne emissions of UO_2F_2 and HF from hypothetically breached cylinders; the exposure pathways considered included inhalation and incidental ingestion of soil.

[b] The MEI for the general public was assumed to be located off-site at the point that would yield the largest exposure. Results reported are the maximum values for the time period considered and would result from exposure via inhalation; ingestion of soil (resulting from airborne emissions of UO_2F_2 and HF from hypothetically breached cylinders); and drinking surface water (consequence of the discharge of contaminated runoff water to a surface water body). Potential impacts during the storage period 1999-2028 (values within parentheses) were also evaluated from the use of contaminated groundwater for drinking, irrigating plant foods and fodder, and feeding livestock.

[c] The hazard index is an indicator for potential health effects other than cancer; a hazard index greater than 1 indicates a potential for adverse health effects and a need for further evaluation.

[d] Calculation of population risk is not applicable when the corresponding hazard index for the MEI is less than 1.

[e] Long-term impacts would result from using contaminated groundwater.

[f] NA = not applicable; workers were assumed not to ingest groundwater.

3.4.3 Air Quality

The assessment of air quality impacts from painting cylinders conducted for the no action alternative would also be applicable for the action alternatives because the assessment was based on maximum annual impacts (i.e., the same levels of painting cylinders were assumed). Potential impacts on air quality from these activities are discussed in Section 3.2.3.

The estimated HF emissions for the action alternatives would differ from those for the no action alternative because different numbers of breached cylinders were assumed. The number of hypothetical breaches and estimated resulting HF concentrations at the current storage site are given in Table 3.25. The estimated 0.14 : g/m^3 maximum 24-hour average HF concentration for the Portsmouth site is considerably below the Tennessee 24-hour average standard of 2.9 : g/m^3, used here for comparison. The state of Ohio does not have an air quality standard for HF.

TABLE 3.25 Estimated Number of Breached Cylinders, Maximum HF Emissions, and Average Maximum HF Concentrations at the Portsmouth Site under the Action Alternatives

Maximum Number of Breaches Starting in a Single Year	Maximum Total Number of Active Breaches in a Single Year	Maximum HF Concentration (μg/m^3)	
		24-Hour Average	Annual Average
1	4	0.14	0.015

3.4.4 Water and Soil

3.4.4.1 Surface Water

The estimated number of cylinder breaches assumed to occur during continued cylinder storage for the action alternatives was used to calculate potential impacts to surface water quality. Each breached cylinder was assumed to release a maximum of 4 lb (1.8 kg) of uranium over 4 years; additional details on the methodology used to evaluate the impacts are given in Appendix C of the PEIS and Tomasko (1997b).

The estimated maximum uranium concentration in runoff water leaving the yards would be about 25 μg/L (6 pCi/L) for the Portsmouth site. This concentration would occur in about the year 2018. After leaving the yards, the contaminated runoff was assumed to flow without loss to the nearest surface water, where it would mix and be diluted. For average flow conditions, the dilution would be large enough that the maximum concentrations would be less than 2 μg/L (0.5 pCi/L) (see Table 3.26). This concentration is less than the EPA proposed drinking water MCL for uranium of 20 μg/L, used here for comparison. The contaminated water would then mix with water in the Scioto River, which would result in even greater dilution. Because of this mixing, impacts to the major river would not be measurable.

3.4.4.2 Groundwater

Methods for estimating groundwater impacts were the same as those used for the no action alternative (Section 3.2.4.2); however, a larger number of cylinder breaches was assumed to occur. Conservative estimates of the concentrations of uranium in groundwater were obtained by assuming the surface value to be equal to the maximum concentration in water leaving each yard during a time

TABLE 3.26 Maximum Uranium Concentrations in Surface Waters for Continued Cylinder Storage at the Portsmouth Site under the Action Alternatives

Receiving Water	Dilution Factor	Maximum Concentration (:g/L)
Little Beaver Creek	26	1
Scioto River	2,240	0.0005

interval of approximately 20 years; this time interval corresponds to the time over which the concentration in surface water would be higher than half of its maximum value.

At the end of the time period considered for the action alternatives (1999–2028), the concentration of uranium in groundwater directly below the edge of the surface contamination at the Portsmouth site is estimated to be about 0.09 :g/L (0.02 pCi/L), for a retardation factor of 5 (Table 3.27) (Tomasko 1997b). This concentration is less than the proposed EPA drinking water MCL for uranium of 20 :g/L, used here for comparison (EPA 1996).

A maximum concentration of about 4 :g/L (1 pCi/L) would occur between the years 2070 and 2080 at the site, assuming a retardation factor of 5. The maximum concentration would be less than the EPA proposed drinking water guideline. For a retardation factor of 50 (relatively immobile uranium transport), the maximum concentration would be about 10 times less. This concentration would occur between the years 2500 and 2700.

Assuming a retardation factor of 5 and a distance of 1,000 ft (300 m) from the edge of the source area, the maximum concentration of uranium would be about 3 :g/L (0.7 pCi/L) at the Portsmouth site. For less mobile conditions (retardation of 50), the maximum concentrations would be about 10 times less.

3.4.4.3 Soil

The maximum uranium concentration in soil for a distribution coefficient of 50 (relatively high sorption capacity) would be about 1.2 :g/g at the Portsmouth site. If the soil had a lower sorption capacity (distribution coefficient of 5), the soil concentration would be about 10 times lower. This maximum soil concentration associated with continued cylinder storage under the action alternatives is much lower than the recommended EPA guideline levels of 230 :g/g for residential soil or 1,000 :g/g for industrial soil (EPA 1995).

TABLE 3.27 Groundwater Concentrations for Continued Cylinder Storage for Two Soil Characteristics at the Portsmouth Site under the Action Alternatives[a]

	X = 0			X = 1,000 ft		
	Concentration		Time (yr) to Maximum Concentration	Concentration		Time (yr) to Maximum Concentration
Parameter	pCi/L	: g/L		pCi/L	: g/L	
Retardation Factor = 5						
Concentration at 30 years	0.02	0.09				
Maximum concentration	0.8	3.5	>70	0.7	2.8	>70
Retardation Factor = 50						
Maximum concentration	0.08	0.4	>500	0.07	0.3	>500

[a] Retardation factors describe how readily a contaminant such as uranium moves through the soil in groundwater. A retardation factor of 5 represents a case in which the uranium moves relatively rapidly in the soil; a retardation factor of 50 represents a case in which uranium moves slowly.

3.4.5 Socioeconomics

The methods used to assess socioeconomic impacts of continued cylinder storage for the action alternatives were the same as those used for the no action alternative (Section 3.2.5). Impacts are presented in Table 3.28. Under the action alternatives, continued storage activities would still have a negligible impact on socioeconomic conditions in the ROI surrounding the site.

3.4.6 Ecology

For continued cylinder storage under the action alternatives, the maximum annual average HF concentration would be 0.015 : g/m^3 (Section 3.4.3). Resulting impacts to biota would be expected to be negligible. Contamination of soils near the storage yards by surface runoff could result in a maximum uranium concentration of 1.2 : g/g at the Portsmouth site (Section 3.4.4.3). Impacts to vegetation would be

TABLE 3.28 Potential Socioeconomic Impacts of Continued Cylinder Storage at the Portsmouth Site under the Action Alternatives[a]

Parameter	Impacts from Operations[b]
Economic activity in the ROI	
Direct jobs	20
Indirect jobs	10
Total jobs	30
Income ($ million)	
Direct income	0.5
Total income	0.6
Population in-migration into the ROI	10
Housing demand	
Number of units in the ROI	0
Public finances	
Change in ROI fiscal balance (%)	0.0

[a] There would be no impacts from construction, since no construction activities are planned for continued cylinder storage at the Portsmouth site.

[b] Impacts for peak year of operations. Duration of operations was assumed to be 30 years (1999–2028).

expected to be negligible to low. Surface runoff from the storage yards would have a maximum uranium concentration of 25 :g/L (6 pCi/L) at the Portsmouth site (Section 3.4.4.1). Resulting impacts to maximally exposed organisms in the nearest receiving surface water body would be expected to be negligible. Uranium concentrations in groundwater would be considerably less, and resulting impacts to aquatic biota would be negligible.

Uranium concentrations in groundwater following the cylinder removal period would be very low, and long-term impacts to aquatic biota would not be expected. Contaminants associated with cylinder storage would not occur in other environmental media following the cylinder removal period.

3.4.7 Waste Management

As for the no action alternative, the principal wastes that are expected to be generated during continued cylinder storage are uranium-contaminated scrap metal from breached cylinders and failed valves, assumed to be LLW, and solid process residue from cylinder painting, assumed to be LLMW. The total amounts of these waste types estimated to be generated for continued cylinder storage under the action alternatives are given in Table 3.29. The annual amount of LLW generated would be less than 2% of current site LLW generation. The maximum annual amount of LLW generated during continued cylinder storage would represent less than 1% of the annual DOE LLW generation.

For the Portsmouth site, the annual amount of LLMW generation would be less than 1% of site LLMW generation and less than 1% of the total nationwide LLMW load. Overall, the waste input resulting from the continued storage of cylinders under the action alternatives would have negligible impacts on waste management capabilities at the Portsmouth site. Impacts on national waste management capabilities would be negligible.

TABLE 3.29 Waste Generated at the Portsmouth Site during Continued Cylinder Storage under the Action Alternatives (1999–2028)

Waste (m^3)	
LLW[a]	LLMW[b]
350	204

[a] Contaminated scrap metal from breached cylinders that would require emptying.

[b] Inorganic process residues from cylinder painting.

3.4.8 Resource Requirements

Resource requirements for continued cylinder storage under the action alternatives are summarized in Table 3.30. The lower end of the range of annual resource requirements is lower

TABLE 3.30 Resource Requirements for Operations for Continued Cylinder Storage at the Portsmouth Site under the Action Alternatives[a]

Materials/Resource	Consumption during 1999–2028
Solids	
55-gal drums (each)	26 – 50[b]
Cylinder valves (1-in.) (each)	2 – 4
Liquids (gal/yr)	
Gasoline	810 – 1,600
Diesel fuel	2,100 – 4,100
Zinc-based paint	1,400 – 2,700

[a] There would be no requirements for construction, since no construction activities are planned for continued cylinder storage at the Portsmouth site.

[b] Values reported as ranges generally correspond to varying resource requirements during years for which activities are planned.

than the lower values for the no action alternative because maintenance of the decreasing cylinder inventory would require fewer resources.

The total quantities of commonly used construction materials needed for continued storage under the action alternatives are expected to be small compared with local sources. No strategic and critical materials are projected to be consumed for either construction or operations. Small amounts of diesel fuel and gasoline are projected to be used. The required material resources during operations would appear to be readily available.

3.4.9 Land Use

Potential land-use impacts would be the same as those discussed in Section 3.2.9.

3.4.10 Cultural Resources

Potential impacts to cultural resources under the action alternatives would be identical to those discussed in Section 3.2.10.

3.4.11 Environmental Justice

Because no screening criteria limits for radiological and chemical sources under normal operations were exceeded under the action alternatives, no disproportionate impacts to minority and low-income populations would be associated with normal operations for continued cylinder storage. The assessment of impacts for potential accidents associated with continued cylinder storage under the action alternatives is similar to that for the no action alternative (Section 3.2.11) in that the same accidents were considered and the consequences of those accidents would be the same. However, because the duration of continued cylinder storage under the action alternatives is 11 years shorter than that assessed for the no action alternative (i.e., 30 years assumed for the action alternatives compared with 41 years assumed for the no action alternative), the risk of these accidents occurring is somewhat lower. However, the conclusion that no disproportionate impacts would be associated with continued cylinder storage under the no action alternative is still applicable for the action alternatives because risks are lower for these alternatives.

3.5 POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED WITH CONTINUED STORAGE OF THE ENTIRE PORTSMOUTH SITE CYLINDER INVENTORY

After the draft PEIS was completed, management responsibility for approximately 2,700 additional cylinders of depleted UF_6 at the Portsmouth site was transferred from USEC to DOE by the signing of two MOAs associated with the privatization of USEC (DOE and USEC 1998a,b). These cylinders are located in X-745-G yard at the Portsmouth site (see Figure 2.2). To account for uncertainties associated with the number of cylinders that would be transferred from USEC to DOE in the future and to provide a bounding analysis of environmental impacts, the final PEIS evaluated the environmental impacts of managing an additional 3,000 cylinders at the Portsmouth site. These analyses are summarized in Chapter 6 of the PEIS; impacts associated with continued cylinder storage under both the no action alternative and the action alternatives are summarized here in Sections 3.5.2 and 3.5.3, respectively.

3.5.1 Approach Used to Evaluate the Environmental Impacts of Continued Storage of the USEC Cylinders

Management of the USEC-generated cylinders must conform with all requirements applicable to the DOE-generated cylinders. These requirements are described in the UF_6 cylinder project management plan (LMES 1997f). For the site-specific evaluation of continued storage of the USEC-generated cylinders, it was assumed that the USEC cylinders would be managed in the same way as were the DOE-generated cylinders. Management activities would include (1) refurbishment of cylinder yards and restacking as necessary, (2) routine and ultrasonic testing inspections of cylinders and valve monitoring and maintenance, (3) cylinder painting as necessary, and (4) repair and/or removal of the contents of any cylinders that might be breached during the storage period.

In general, the USEC-generated cylinders are newer than the DOE-generated cylinders and do not exhibit the heavy external corrosion that can result from long-term storage in substandard conditions. Moreover, since these cylinders would be regularly inspected and maintained while under DOE management, future external corrosion would be expected to be minimal. Nonetheless, for the purpose of analyzing continued cylinder storage impacts in this PEIS, the USEC-generated cylinders were assumed to be essentially the same as the DOE-generated cylinders; i.e., the rate of corrosion and the cylinder breach rate were assumed to be the same.

For the PEIS, under the no action alternative, potential environmental impacts were estimated from continued cylinder storage through the year 2039. Under the action alternatives (long-term storage as UF_6, long-term storage as oxide, use as oxide, use as metal, and disposal as oxide), it was assumed that continued cylinder storage would extend from 2009 through 2028 at the current storage sites. The inclusion of the USEC-generated cylinders would increase the length of some continued storage at the Portsmouth site from the year 2028 through about the year 2034. On the basis of the assumption that the rate of cylinder breaches would be the same for the USEC-generated cylinders as for the DOE-generated cylinders, it was estimated that the number of cylinder breaches would increase by 22% at the Portsmouth site. (This increase corresponds directly to the increase in the cylinder inventory at the site.) These assumptions were applied to estimate the number of breaches that would occur in two cases: (1) if painting the cylinders controlled future corrosion and (2) if corrosion continued at the historic rate. For corrosion-induced breaches, these are very conservative assumptions (i.e., are likely to result in overestimates of the number of breaches), because the USEC-generated cylinders are newer than the DOE cylinders.

3.5.2 Potential Environmental Impacts from Continued Storage of the Entire Site Cylinder Inventory (DOE- and USEC-Generated Cylinders) under the No Action Alternative

3.5.2.1 Human Health and Safety — Normal Operations

3.5.2.1.1 Workers

In general, the continued cylinder storage of the additional USEC cylinders at the Portsmouth site would increase the overall level of activity of involved workers by approximately 20%, resulting in a corresponding increase in the total radiation dose to the worker population over the duration of the program (total dose of about 460 person-rem). However, this increase in the radiation dose would not change the estimate of less than 1 LCF among workers at the Portsmouth site under the no action alternative In addition, the average annual radiation dose to individual workers associated with management of the additional USEC-generated cylinders would be the same as that reported for the management of DOE-generated cylinders only, because additional cylinder yard workers would be used to perform the necessary activities instead of having the same individuals conduct extra activities Thus, the number of involved workers at the Portsmouth site would increase from about 16 to 20, but the average annual doses to involved workers at the site would remain at about 600 mrem/yr.

The management of USEC-generated cylinders would result in a potential increase in the radiation dose to non-involved workers from airborne releases that would be proportional to the increase in the total cylinder inventory and number of hypothetical cylinder breaches (i.e., the collective dose would increase by approximately 20%, to a total of about 0.016 person-rem). The increase in dose to the noninvolved worker MEI at Portsmouth site would be insignificant (i.e., increase of 0.01 mrem/yr to a total dose of 0.05 mrem/yr). Also, the change in the potential for noncancer health effects from exposure to airborne uranium and HF releases would be such that the hazard index for the noninvolved worker MEI would remain less than 0.0001.

3.5.2.1.2 General Public

The management of USEC-generated cylinders would result in a potential increase in the radiation dose to the public from airborne releases that would be proportional to the increase in the total cylinder inventory and number of hypothetical cylinder breaches (i.e., the dose would increase by approximately 20%, to a total of about 0.07 person-rem). This level of exposure would remain well below levels expected to cause any adverse effects.

The increase in maximum radiation dose to an individual near the Portsmouth site would be insignificant (total dose less than 0.1 mrem/yr). Also, the change in the potential for noncancer health effects from exposure to airborne uranium and HF releases would be such that the maximum hazard index for an individual would remain less than 0.01.

The estimated maximum uranium concentration in groundwater and resulting health effects among member of the public from future cylinder breaches would be the same as that estimated for the management of DOE-generated cylinders (Section 3.2.1.1), because the estimated groundwater concentration for the DOE-generated cylinders was calculated on the basis of hypothetical breaches occurring in the combined area of the C- and E-yards at the Portsmouth site This assumption represents a worst-case scenario in terms of groundwater contamination; additional breaches from USEC cylinders stored in the G-yard would not increase the estimated groundwater concentrations.

3.5.2.2 Human Health and Safety — Accident Conditions

3.5.2.2.1 Physical Hazards

The total number of worker fatalities and injuries associated with continued storage through 2039 of the entire inventory at the Portsmouth site (including USEC cylinders) would be 0.04 fatality and about 50 injuries.

3.5.2.2.2 Accidents Involving Releases of Radiation or Chemicals

For accident consequences, impacts would be the same as those previously discussed for the DOE-generated cylinders (Section 3.2.2), because the types of accidents assessed would involve only a limited amount of material that would be at risk under accident conditions regardless of the number of cylinders in storage (for example, a vehicle-induced fire would be estimated to involve three full cylinders regardless of the number of cylinders at the sites) Although the estimated frequencies of some accidents would increase somewhat in association with the management of the additional USEC-generated cylinders (e.g., cylinder handling accidents), this increase is not expected to be enough to change the overall expected frequency of specific accidents from the broad ranges used in the PEIS (i.e., likely = greater than or equal to 1 time in 100 years; unlikely = between 1 time in 100 years and 1 time in 10,000 years; extremely unlikely = between 1 time in 10,000 years and 1 time in 1 million years; incredible = less than 1 time in 1 million years)

3.5.2.3 Transportation

The continued storage of the USEC-generated cylinders would result in small additional quantities of LLW and LLMW requiring shipment annually (from cylinder monitoring and maintenance activities) This additional waste would result in less than one additional waste shipment each year. Because of the small number of shipments and the low concentrations of contaminants expected, the potential environmental impacts from these shipments would be negligible

3.5.2.4 Air Quality

No cylinder yard refurbishment is currently expected to be required at the Portsmouth site for the USEC-generated cylinders stored in X-745-G yard; however, the cylinders will require restacking within the X-745-G yard to meet spacing requirements (DOE and USEC 1998a). Concentrations of criteria air pollutants at the Portsmouth site boundaries due to cylinder restacking will remain well below air quality standards.

The additional cylinders would also require painting. Assuming maximum concentrations of criteria pollutants at the site boundaries increase by 20% over those given in Table 3.13, the maximum concentrations would still be less than 1% of the air quality standards. Painting the USEC-generated cylinders to protect them from external corrosion, as needed, would also not have a significant impact on regional ozone formation.

Under the no action alternative, potential concentrations of HF due to hypothetical breaches of some USEC-generated cylinders were estimated to remain low at the Portsmouth site (less than 0.8 μg/m^3 maximum 24-hour average), whether or not corrosion control was assumed. The State of Ohio does not have an ambient air quality standard for HF.

3.5.2.5 Water and Soil

Since no construction activities are planned for the Portsmouth site, no impacts would be expected in assessment areas such as changes in runoff, recharge to underlying aquifers, and changes in soil permeability or erosion potential. Additional water use for continued storage of USEC-generated cylinders was roughly estimated to be 13,000 gal/yr for operations at the Portsmouth site. Total water use would be 73,000 gal/yr for operations at Portsmouth.

Releases from hypothetical breaches of the USEC cylinders would, in general, increase concentrations in groundwater in some areas of the site (i.e., in the areas near or in USEC cylinder storage yards). However, maximum concentrations calculated for evaluating the worst-case impacts to groundwater at the Portsmouth site (combined C- and E-yards) under the no action alternative would remain the same as those described in Section 3.2.4.2. These concentrations would not change because the number of cylinders at the combined C- and E-yards would be the same (USEC cylinders would be stored at other yards) and because, in the groundwater modeling method used, contaminant plumes emanating from the vicinity of the yards are assumed to be independent and to not interact because of the distance separating the yards, the short travel distance to the assumed receptor (i.e., 1,000 ft), and limited plume spreading caused by lateral dispersion. Therefore, although concentrations of uranium in groundwater beneath some cylinder storage yards would increase because of the addition of the USEC cylinders, the maximum concentrations for the entire site would still be represented by the values given in Section 3.2.4.2 (i.e., 5 ug/L).

The maximum concentration in surface water bodies adjacent to the sites would also stay about the same (0.7 μg/L) because of dilution in these water bodies. For soil, the worst-case concentration would remain the same (about 1 μg/g); runoff from the USEC yard would not mix with runoff from the C- and E- yards to increase local soil contaminant concentrations.

3.5.2.6 Socioeconomics

Additional operational activities at the Portsmouth site would create 4 additional direct jobs and 7 additional total jobs per year (direct and indirect). During operations, additional direct and total income at the Portsmouth site would be \$0.1 million and \$0.2 million per year, respectively.

The total socioeconomic impacts from continued cylinder storage at the Portsmouth site (when both DOE- and USEC-generated cylinders are considered) would be 24 direct jobs and 37 total jobs per year during operations, and \$0.7 million/yr direct income and \$0.9 million/yr total income during operations. The total employment and income created in the ROI for the site would represent a very small change (less than 0.01%) in projected growth in these indicators of overall regional activity. The total expected in-migration would have only a low impact on regional population growth rates and would require a very small proportion (less than 1%) of vacant housing stock at the site. No significant impacts on local public finances would be expected.

3.5.2.7 Ecology

Impacts to ecological resources from the continued storage of the additional USEC-generated cylinders would be minimal. Concentrations of uranium in soil, groundwater, and surface water would remain well below benchmark values for toxic and radiological effects. (Benchmarks are given in Section C.3.3 of the PEIS.)

3.5.2.8 Waste Management

Painting at the Portsmouth site would not significantly increase the 1% proportion of LLMW generation at the site that would be attributable to the DOE-generated cylinders only. The continued storage of the USEC-generated cylinders together with the DOE-generated cylinders would constitute a negligible potential impact on LLMW management at the Portsmouth site.

3.5.2.9 Resource Requirements

Although the total resources required would increase by approximately 20% over those presented in Section 3.2.8 as a result of the inclusion of USEC-generated cylinders, continued storage activities would not be resource intensive, and no strategic or critical materials would be required. The continued storage of the DOE- and USEC-generated cylinders would have a negligible to low impact on resource requirements at the Portsmouth site.

3.5.2.10 Land Use

The cylinder yard that is planned to be used to store USEC-generated cylinders has already been used as a cylinder yard and thus would not impact land use at the Portsmouth site under the no action alternative.

3.5.2.11 Cultural Resources

The yard for USEC-generated cylinders at the Portsmouth site is located in a previously disturbed area unlikely to contain cultural properties or resources listed on or eligible for the National Register of Historic Places. Therefore, there should be no impacts to cultural resources.

3.5.2.12 Environmental Justice

No disproportionately high and adverse effects to minority or low-income populations would be expected in the vicinity of the Portsmouth site in association with the continued storage of the USEC-generated cylinders.

3.5.3 Potential Environmental Impacts from Continued Storage of the Entire Site Cylinder Inventory (DOE- and USEC-Generated Cylinders) under the Action Alternatives

Under the action alternatives, the inclusion of USEC-generated cylinders would increase the number of cylinders managed by DOE at the Portsmouth site by about 22%. Under the action alternatives, the duration of continued cylinder storage at the Portsmouth site was assumed to be extended by about 6 years, from 2028 to 2034, to account for the time required to process the additional cylinders. The total time of cylinder storage evaluated was increased from 30 to 36 years (i.e., from 1999 to 2028 to 1999 to 2034).

3.5.3.1 Human Health and Safety — Normal Operations

3.5.3.1.1 Workers

Under the action alternatives, the continued storage of the additional USEC cylinders was estimated to increase the total dose to involved workers by about 22%, to a total of 220 person-rem. This would result in less than 1 LCF among involved workers (including both DOE- and USEC-generated cylinders) over the assumed 30-year duration of continued cylinder storage. (The dose to noninvolved workers would remain negligible when compared with the involved worker dose.)

In general, the average annual radiation dose to individual workers associated with management of the additional USEC cylinders would be the same as that reported in Section 3.4.1.1 for DOE-generated cylinders (i.e., 450 mrem/yr; well within applicable standards) because additional workers would be used instead of having the same individuals conduct extra activities at the site.

Slightly increased exposure to chemicals would not be expected to result in health impacts among involved or noninvolved workers. The total estimated hazard index (when both DOE- and USEC-generated cylinders are considered) would be less than 0.00005 for noninvolved workers at the site.

3.5.3.1.2 General Public

The management of USEC-generated cylinders would result in a potential increase in the total radiation dose to the public around the Portsmouth site from airborne releases. The increase would be proportional to the increase in the total cylinder inventory and number of hypothetical cylinder breaches (i.e., approximately 20%). Therefore, it was estimated that the total radiation dose to the general public within 50 mi (80 km) of the Portsmouth site would increase by about 0.01 person-rem, resulting in a total dose of 0.06 person-rem over the period 1999 through 2034. This level of exposure would remain well below levels expected to cause any adverse health effects.

The maximum radiation dose to an individual near the Portsmouth site would also increase because of the additional management of USEC-generated cylinders. However, this increase would be such that the dose to an individual near the site would be less than 0.1 mrem/yr, well within health standards. Similarly, the change in the potential for noncancer health effects from exposure to airborne uranium and HF releases would be such that the maximum total hazard index for an individual due to continued cylinder storage activities would remain less than 0.1.

Potential short- and long-term health impacts from surface and groundwater contamination associated with the management of the USEC-generated cylinders would be the same as those for DOE-generated cylinders discussed in Section 3.4.1. This result would occur because the modeling of releases to groundwater at the Portsmouth site for the DOE-generated cylinders represents a worst-case scenario; additional breaches from USEC cylinders stored in a different yard would not increase the estimated groundwater concentrations.

3.5.3.2 Human Health and Safety — Accident Conditions

3.5.3.2.1 Physical Hazards

The total number of worker fatalities and injuries associated with continued storage of the entire inventory under the action alternatives at the Portsmouth site (including USEC cylinders) would be about 0.024 fatalities and about 30 injuries.

3.5.3.2.2 Accidents Involving Releases of Radiation or Chemicals

For accident consequences, impacts would be the same as those for the DOE-generated cylinders under the no action alternative discussed in Section 3.4.2. Although the estimated frequencies of some accidents would increase somewhat in association with the management of the additional USEC cylinders, this increase would not be expected to be enough to change the overall expected frequency of specific accidents from the broad ranges used for this analysis.

3.5.3.3 Transportation

The continued storage of the USEC-generated cylinders under the action alternatives would result in small additional quantities of LLW and LLMW requiring shipment annually (from cylinder monitoring and maintenance activities) This additional waste would result in less than one additional waste shipment each year. Because of the small number of shipments and the low concentrations of contaminants expected, the potential environmental impacts from these shipments would be negligible.

3.5.3.4 Air Quality

The continued storage of additional USEC cylinders at the Portsmouth site through the year 2034 would not result in significant impacts to air quality. The estimated concentrations of criteria pollutants from continued storage activities at the site would remain within applicable standards and guidelines. The estimated maximum 24-hour average HF concentration at the Portsmouth site would increase from about 0.14 to about 0.44 µg/m^3.

3.5.3.5 Water and Soil

Additional water use for continued storage of USEC-generated cylinders at the Portsmouth site under the action alternatives was roughly estimated to be 13,000 gal/yr for operations. The estimated total water use would be about 73,000 gal/yr during operations at Portsmouth.

As discussed in Section 3.5.2.5, the overall impacts to surface water, groundwater, and soil from the continued storage of USEC cylinders would be the same as those estimated for the DOE-generated cylinders in Section 3.4.4.1 through 3.4.4.3. The estimated maximum groundwater uranium concentration from continued storage at the Portsmouth site (i.e., 4 : g/L) would not change as a result of considering the USEC cylinders. Potential groundwater impacts would be mitigated by collecting and treating runoff from the cylinder yards and by identifying and repairing breached cylinders as soon as possible. The estimated maximum soil uranium concentration would remain less than 2 : g/g, well within the 230 : g/g guideline used for comparison.

3.5.3.6 Socioeconomics

Operational activities at the Portsmouth site would create 4 additional direct jobs and 7 additional total jobs per year (direct and indirect). During operations, additional direct and total income at the Portsmouth site would be \$0.1 million and \$0.2 million per year, respectively.

The total socioeconomic impacts from continued cylinder storage at the Portsmouth site (when both DOE- and USEC-generated cylinders are considered) would be 24 direct jobs and 37 total jobs per year during operations, and \$0.6 million/yr direct income and \$ 0.8 million/yr total income during operations. The total employment and income created in the ROI for the site would represent a very small change in projected growth in these indicators of overall regional activity. The total expected in-migration would have only a low impact on regional population growth rates; no significant impacts on local public finances would be expected.

3.5.3.7 Ecology

Impacts to ecological resources from continued storage of the total cylinder inventory would be the same as those discussed under the action alternatives for DOE-generated cylinder only, that is, negligible to low (Section 3.4.6). Concentrations of uranium in groundwater and surface water would remain well below benchmark values for toxic and radiological effects (see Section C.3.3 of the PEIS). The maximum estimated soil uranium concentration would be less than the benchmark concentration.

3.5.3.8 Waste Management

Continued storage of USEC-generated cylinders at the Portsmouth site under the action alternatives would increase the total amounts of LLW and LLMW generated by about 20% (to totals of about 430 m^3 and 250 m^3, respectively, see Table 3.29). These amounts would still constitute negligible to low impacts to waste management capabilities at the Portsmouth site and at the national level.

3.5.3.9 Resource Requirements

Although the total resources required would increase by approximately 20% over those presented in Section 3.4.8 as a result of the inclusion of USEC-generated cylinders, continued storage activities would not be resource intensive, and no strategic or critical materials would be required. The continued storage of the DOE- and USEC-generated cylinders under the action alternatives would have a negligible to low impact on resource requirements at the Paducah site.

3.5.3.10 Land Use

The cylinder yard that is planned to be used to store USEC-generated cylinders has already been used as a cylinder yard and thus would not impact land use at the Portsmouth site under the action alternatives.

3.5.3.11 Cultural Resources

The yard for USEC-generated cylinders at the Portsmouth site is located in a previously disturbed area unlikely to contain cultural properties or resources listed on or eligible for the National Register of Historic Places. Therefore, there should be no impacts to cultural resources.

3.5.2.12 Environmental Justice

No disproportionately high and adverse effects to minority or low-income populations would be expected in the vicinity of the Portsmouth site in association with the continued storage of the USEC-generated cylinders under the action alternatives.

4 ENVIRONMENTAL IMPACTS OF OPTIONS FOR PREPARING CYLINDERS FOR SHIPMENT OR LONG-TERM STORAGE AT THE PORTSMOUTH SITE

The term "cylinder preparation" refers to the activities necessary to prepare depleted UF_6 cylinders for off-site transportation. For this report, transportation of depleted UF_6 cylinders was assumed to be required from the Portsmouth site to either a conversion facility or a long-term storage site (for long-term storage of UF_6). UF_6 cylinders have been transported safely by truck and rail between DOE facilities, electric utilities, reactor fuel fabricators, and research nuclear reactors for about 40 years.

Depleted UF_6 cylinders were designed, built, tested, and certified to meet U.S. Department of Transportation (DOT) requirements for shipment by truck and rail. The DOT requirements, specified in Title 49 of the CFR, are intended to maintain the safety of shipments during both routine and accident conditions. Cylinders meeting the DOT requirements could be loaded directly onto specially designed truck trailers or railcars for shipment. However, after several decades in storage, some cylinders no longer meet the DOT requirements. Two cylinder preparation options, which address different approaches that could be used to transport the depleted UF_6 stored in these cylinders, are considered in this report. These two options, discussed in detail in Section 4.2, are a cylinder overcontainer option and a cylinder transfer option.

Cylinder Preparation Options

Cylinder preparation refers to the activities necessary to prepare depleted UF_6 cylinders for off-site transportation. Depleted UF_6 cylinders were designed, built, tested, and certified to meet U.S. Department of Transportation (DOT) requirements for shipment by truck and rail. However, after several decades in storage, some cylinders no longer meet these requirements. Two options for preparing these cylinders for shipment are considered in the PEIS.

Cylinder Overcontainers. Cylinders that do not meet DOT requirements could be placed inside protective metal "overcontainers" for shipment. These reusable overcontainers, which would be slightly larger than a cylinder, would be designed to meet all DOT requirements.

Cylinder Transfer. In this option, the depleted UF_6 in cylinders that do not meet DOT requirements would be transferred to new cylinders capable of being transported.

Note: For both options, cylinders that meet DOT shipment requirements would be shipped directly.

It is unknown exactly how many of the depleted UF_6 cylinders currently do not meet the DOT transportation requirements. The potential problems with cylinders are related to three DOT requirements that must be satisfied before shipment: (1) cylinders must be filled to less than 62% of the maximum capacity (the fill-limit was reduced to 62% from 64% around 1987); (2) the pressure within cylinders must be less than atmospheric pressure; and (3) cylinders must be free of damage or defects, such as dents, and have a specified minimum wall thickness. Cylinders not meeting these requirements are referred to as overfilled, overpressurized, and substandard, respectively. Some cylinders may fail to meet more than one requirement.

The assessment of cylinder preparation options considers the environmental impacts of preparing the entire DOE-generated depleted UF_6 cylinder inventory at the Portsmouth site for shipment over a 20-year period. Prior to shipment, each cylinder would be inspected to determine if it meets DOT requirements. This inspection would include a record review to determine if the cylinder is overfilled; a visual inspection for damage or defects; a pressure check to determine if the cylinder is overpressurized; and an ultrasonic wall thickness measurement (if necessary based on the visual inspection). If a cylinder passed the inspection, the appropriate documentation would be prepared, and the cylinder would be loaded directly for shipment. If a cylinder failed the inspection, it would be prepared using one of the two cylinder preparation options (see Section 4.2).

The estimated number of cylinders not meeting DOT requirements at the Portsmouth site would range from 2,600 to 13,388 (the entire Portsmouth inventory of DOE-generated cylinders). On the basis of this estimate, there would be a need to provide overcontainer or cylinder transfer capacities for about 130 to 670 cylinders annually and to prepare from 0 to 540 standard cylinders per year for shipment.

The environmental impacts from the cylinder preparation options were evaluated on the basis of information provided in the engineering analysis report (Lawrence Livermore National Laboratory [LLNL] 1997), i.e., preconceptual design data for each option, including descriptions of facility layouts; resource requirements; estimated effluents, wastes, and emissions; and potential accident scenarios. In the engineering analysis report, estimates for cylinder transfer operations ranged in capacity from 320 to 1,600 cylinders processed per year; whereas overcontainer and standard cylinder operations were addressed on a site-specific basis for a reference case for each site (i.e., 260 cylinders/yr with overcontainers for the Portsmouth site), with some information provided on scaling up or down from the reference case (LLNL 1997). Supporting data for the overcontainer and transfer facility analyses were derived by Folga (1996b) using information provided in the engineering analysis report (LLNL 1997).

For assessment purposes, it was assumed that all cylinders would require transportation. However, the actual need for transportation of cylinders would depend on site selection and other considerations to be addressed in the second tier of the NEPA process.

4.1 SUMMARY OF CYLINDER PREPARATION OPTION IMPACTS

This section provides a summary of the potential environmental impacts associated with the cylinder preparation options at the Portsmouth site. Additional discussion and details related to the assessment methodologies and results for individual areas of impact are provided in Section 4.3.

After the draft PEIS was completed, management responsibility for approximately 2,700 additional cylinders of depleted UF_6 at the Portsmouth site was transferred from USEC to DOE. To provide a bounding analysis of environmental impacts, the PEIS evaluated the environmental impacts of managing an additional 3,000 cylinders at the Portsmouth site. The impacts associated with preparation of the total cylinder inventory for shipment (including USEC-generated cylinders) are summarized in Section 4.4. A summary of the estimated environmental impacts associated with preparation of the DOE-generated cylinders only and for the total cylinder inventory (DOE-generated plus USEC-generated) is presented in Table 4.1. Ranges of impacts are presented for the over-container option, the cylinder transfer option, and the preparation of standard cylinders (which is required for either option). On the basis of information in Table 4.1 and Sections 4.3 and 4.4, the following general conclusions may be drawn:

- For the cylinder overcontainer option and preparation of standard cylinders, impacts during normal operations would be small and limited to involved workers. No impacts to the off-site public or the environment would occur because no releases would be expected and no construction activities would be required.

- For the cylinder transfer option, impacts during construction and normal operations would generally be small and limited primarily to involved workers. Some small off-site releases of hazardous and nonhazardous materials would occur, although these would have negligible impacts on the off-site public and environment. Construction activities could temporarily impact air quality, but concentrations of criteria pollutants would all be within standards.

- For all cylinder preparation options, there is a potential for low-probability accidents (UF_6 cylinders engulfed in a fire) that could have large consequences. The accident impacts would be limited primarily to workers, but off-site impacts are possible.

4.2 DESCRIPTION OF OPTIONS

This section provides a brief summary of the cylinder preparation options considered in the assessment of impacts. The information is based on preconceptual design data provided in the engineering analysis report (LLNL 1997). The engineering analysis report includes much more detailed information, including descriptions of facility layouts, resource requirements, estimates of effluents, wastes, and emissions, and descriptions of potential accident scenarios.

Prior to shipment, each cylinder would be inspected to determine if it meets DOT requirements. This inspection would include a record review to determine if the cylinder is overfilled; a visual inspection for damage or defects; a pressure check to determine if the cylinder is overpressurized; and an ultrasonic wall thickness measurement (if necessary based on the visual inspection). If a cylinder passed the inspection, the appropriate documentation would be prepared, and the cylinder would be loaded directly for shipment.

TABLE 4.1 Summary of Cylinder Preparation Impacts for the Portsmouth Site[a]

Impacts from Preparation of Problem Cylinders[b]		Impacts from Preparation of Standard Cylinders[c]
Cylinder Overcontainer Operations	Cylinder Transfer Operations	
Human Health – Normal Operations: Radiological		
Involved Workers: Total collective dose: 48 – 240 person-rem [60 – 300 person-rem] Total number of LCFs: 0.02 – 0.1 LCF	**Involved Workers:** Total collective dose: 410 – 690 person-rem [510 – 830 person-rem] Total number of LCFs: 0.2 – 0.3 LCF	**Involved Workers:** Total collective dose: 0 – 120 person-rem [0 – 150 person-rem] Total number of LCFs: 0 – 0.05 LCF [0 – 0.06 LCF]
Noninvolved Workers: No impacts	**Noninvolved Workers:** Annual dose to MEI : $1.9 \times 10^{-6} – 7.9 \times 10^{-6}$ mrem/yr Annual cancer risk to MEI: $7 \times 10^{-13} – 3 \times 10^{-12}$ per year Total collective dose: $2.6 \times 10^{-5} – 1.1 \times 10^{-4}$ person-rem [$3.2 \times 10^{-5} – 1.3 \times 10^{-4}$ person-rem] Total number of LCFs: $1 \times 10^{-8} – 4 \times 10^{-8}$ LCF [$1 \times 10^{-8} – 5 \times 10^{-8}$ LCF]	**Noninvolved Workers:** No impacts
General Public: No impacts	**General Public:** Annual dose to MEI: $3.3 \times 10^{-5} – 4.4 \times 10^{-5}$ mrem/yr Annual cancer risk to MEI: 2×10^{-11} per year Total collective dose to population within 50 miles: $3.1 \times 10^{-4} – 1.3 \times 10^{-3}$ person-rem [$3.8 \times 10^{-4} – 1.6 \times 10^{-3}$ person-rem] Total number of LCFs in population within 50 miles: $2 \times 10^{-7} – 7 \times 10^{-7}$ LCF [$2 \times 10^{-7} – 8 \times 10^{-7}$ LCF]	**General Public:** No impacts
Human Health – Normal Operations: Chemical		
Noninvolved Workers: No impacts	**Noninvolved Workers:** No impacts	**Noninvolved Workers:** No impacts
General Public: No impacts	**General Public:** No impacts	**General Public:** No impacts

TABLE 4.1 (Cont.)

Impacts from Preparation of Problem Cylinders[b]		
Cylinder Overcontainer Operations	Cylinder Transfer Operations	Impacts from Preparation of Standard Cylinders[c]
	Human Health – Accidents: Radiological	
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):
Dose to MEI: 0.02 rem	Dose to MEI: 0.02 rem	Dose to MEI: 0.02 rem
Risk of LCF to MEI: 8×10^{-6}	Risk of LCF to MEI: 8×10^{-6}	Risk of LCF to MEI: 8×10^{-6}
Collective dose: 16 person-rem	Collective dose: 16 person-rem	Collective dose: 16 person-rem
Number of LCFs: 6×10^{-3}	Number of LCFs: 6×10^{-3}	Number of LCFs: 6×10^{-3}
General Public: Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):
Dose to MEI: 0.013 rem	Dose to MEI: 0.013 rem	Dose to MEI: 0.013 rem
Risk of LCF to MEI: 6×10^{-6}	Risk of LCF to MEI: 6×10^{-6}	Risk of LCF to MEI: 6×10^{-6}
Collective dose to population within 50 miles: 32 person-rem	Collective dose to population within 50 miles: 32 person-rem	Collective dose to population within 50 miles: 32 person-rem
Number of LCFs in population within 50 miles: 0.02 LCF	Number of LCFs in population within 50 miles: 0.02 LCF	Number of LCFs in population within 50 miles: 0.02 LCF
	Human Health – Accidents: Chemical	
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 1,000 persons	Number of persons with potential for adverse effects: 1,000 persons	Number of persons with potential for adverse effects: 1,000 persons
Number of persons with potential for irreversible adverse effects: 110 persons	Number of persons with potential for irreversible adverse effects: 110 persons	Number of persons with potential for irreversible adverse effects: 110 persons
General Public: Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 650 persons	Number of persons with potential for adverse effects: 650 persons	Number of persons with potential for adverse effects: 650 persons
Number of persons with potential for irreversible adverse effects: 1 person	Number of persons with potential for irreversible adverse effects: 1 persons	Number of persons with potential for irreversible adverse effects: 1 person

TABLE 4.1 (Cont.)

Impacts from Preparation of Problem Cylinders[b]		Impacts from Preparation of Standard Cylinders[c]
Cylinder Overcontainer Operations	Cylinder Transfer Operations	
	Human Health — Accidents: Physical Hazards	
Operations: **All Workers:** 0.007 – 0.041 [0.01 – 0.05] worker fatality, approximately 10 – 54 [12 – 70] worker injuries	**Construction and Operations:** **All Workers:** 0.22 – 0.31 [0.27 – 0.38] worker fatality, approximately 110 – 240 [130 – 290] worker injuries	**Operations:** **All Workers:** 0 – 0.025 [0 – 0.031] worker fatality, approximately 0 – 33 [0 – 40] worker injuries
	Air Quality	
Construction: Not applicable	**Construction:** 24-hour PM_{10} impacts potentially as large as 36% of standard. Concentrations of other criteria pollutants all below 7% of respective standards.	**Construction:** Not applicable
Operations: Concentrations of all criteria pollutants below 0.02% of respective standards.	**Operations:** Concentrations of all criteria pollutants below 0.04% of respective standards.	**Operations:** Concentrations of all criteria pollutants below 0.01% of respective standards.
	Water	
Construction: Not applicable	**Construction:** Negligible impacts to surface water and groundwater	**Construction:** Not applicable
Operations: None to negligible impacts for runoff, floodplains, recharge, and depth to groundwater; estimated surface water and groundwater concentrations would not exceed drinking water standards	**Operations:** None to negligible impacts for runoff, floodplains, recharge, and depth to groundwater; estimated surface water and groundwater concentrations would not exceed drinking water standards	**Operations:** None to negligible impacts for runoff, floodplains, recharge, and depth to groundwater; estimated surface water and groundwater concentrations would not exceed drinking water standards
	Soil	
Construction: Not applicable	**Construction:** Negligible, but temporary, impacts	**Construction:** Not applicable
Operations: No impacts	**Operations:** No impacts	**Operations:** No impacts

TABLE 4.1 (Cont.)

Impacts from Preparation of Problem Cylinders[b]		Impacts from Preparation of Standard Cylinders[c]
Cylinder Overcontainer Operations	Cylinder Transfer Operations	
Socioeconomics[d]		
Jobs: <5 peak year, preoperations; 100 per year over 20 years, operations [over 26 years, operations]	**Jobs** 190 peak year, construction; 160 per year over 20 years, operations [over 26 years, operations]	**Jobs:** <5 peak year, preoperations; 50 per year over 20 years, operations [over 26 years operations]
Income: $0.1 million peak year, preoperations; $6 million per year over 20 years, operations [over 26 years, operations]	**Income:** $8 million peak year, construction; $8 million per year over 20 years, operations [over 26 years, operations]	**Income:** $0.1 million peak year, preoperations; $3 million per year over 20 years, operations [over 26 years, operations]
Preoperations and Operations: Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances	**Construction and Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances	**Preoperations and Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances
Ecology		
Construction: Not applicable	**Construction:** Potentially moderate impacts to vegetation, wildlife, and wetlands	**Construction:** Not applicable
Operations: Negligible impacts	**Operations:** Negligible impacts	**Operations:** No impacts
Waste Management		
No impacts on regional or national waste management operations	No impacts on regional or national waste management operations	No impacts on regional or national waste management operations
Resource Requirements		
No impacts from resource requirements (such as electricity or materials) on the local or national scale	No impacts from resource requirements (such as electricity or materials) on the local or national scale	No impacts from resource requirements (such as electricity or materials) on the local or national scale
Land Use		
No impacts	Use of approximately 14 acres; negligible impacts	No impacts
Cultural Resources		
Construction: No impacts	**Construction:** Cannot be determined	**Construction:** No impacts
Operations: No impacts	**Operations:** No impacts	**Operations:** No impacts

Footnotes appear on next page.

TABLE 4.1 (Cont.)

[a] In general, the overall environmental consequences from managing the total cylinder inventory (total of USEC-generated and DOE-generated cylinders) are the same as those from managing the DOE-generated cylinders only. In this table, when the consequences for the total inventory differ from those for the DOE-generated cylinders only, the consequences for the total inventory are presented in brackets following the consequences for DOE cylinders only. LCF = latent cancer fatality, MEI = maximally exposed individual, PM_{10} = particulate matter with a mean diameter of 10 :m or less, ROI = region of influence.

[b] Problem cylinders are cylinders not meeting DOT transportation requirements, because they are either (1) overfilled, (2) overpressurized, or (3) damaged or substandard with respect to wall thickness.

[c] These impacts must be added to those for either of the two options for preparation of problem cylinders.

[d] For construction, direct jobs and direct income are reported for the peak construction year. For operations, direct jobs and income are presented as annual averages. See Section 4.3.5 for details on indirect impacts in the Paducah site ROI.

The preparation of standard cylinders for shipment (cylinders that meet DOT requirements) would include inspection activities, unstacking, on-site transfer, and loading onto a truck trailer or railcar. The cylinders would be secured using the appropriate tiedowns, and the shipment would be labeled in accordance with DOT requirements. Handling and support equipment and procedures for on-site movement and loading the cylinders would be of the same type currently used for cylinder management activities at the three storage sites.

4.2.1 Cylinder Overcontainers

Cylinder overcontainers are one option for transporting cylinders that do not meet DOT requirements. An overcontainer is simply a container into which a cylinder would be placed for shipment. The metal overcontainer would be designed, tested, and certified to meet all DOT shipping requirements. The overcontainer would be suitable to contain, transport, and store the cylinder contents regardless of cylinder condition. In addition, the overcontainers could be designed as pressure vessels, enabling the withdrawal of the depleted UF_6 from the cylinder in an autoclave (a device used to heat cylinders using hot air).

The type of overcontainer evaluated in the PEIS, shown in Figure 4.1, is a horizontal “clamshell” vessel (LLNL 1997). For transportation, a cylinder not meeting DOT requirements would be placed into an overcontainer already on a truck trailer or railcar. The overcontainer would be closed, secured, and the shipment would be labeled in accordance with DOT requirements. The handling and support equipment for on-site movement and loading the cylinder into the overcontainer would be of the same type currently used for cylinder management activities at the three DOE sites. The overcontainers could be reused following shipment. The overcontainer option would not require the construction of new facilities.

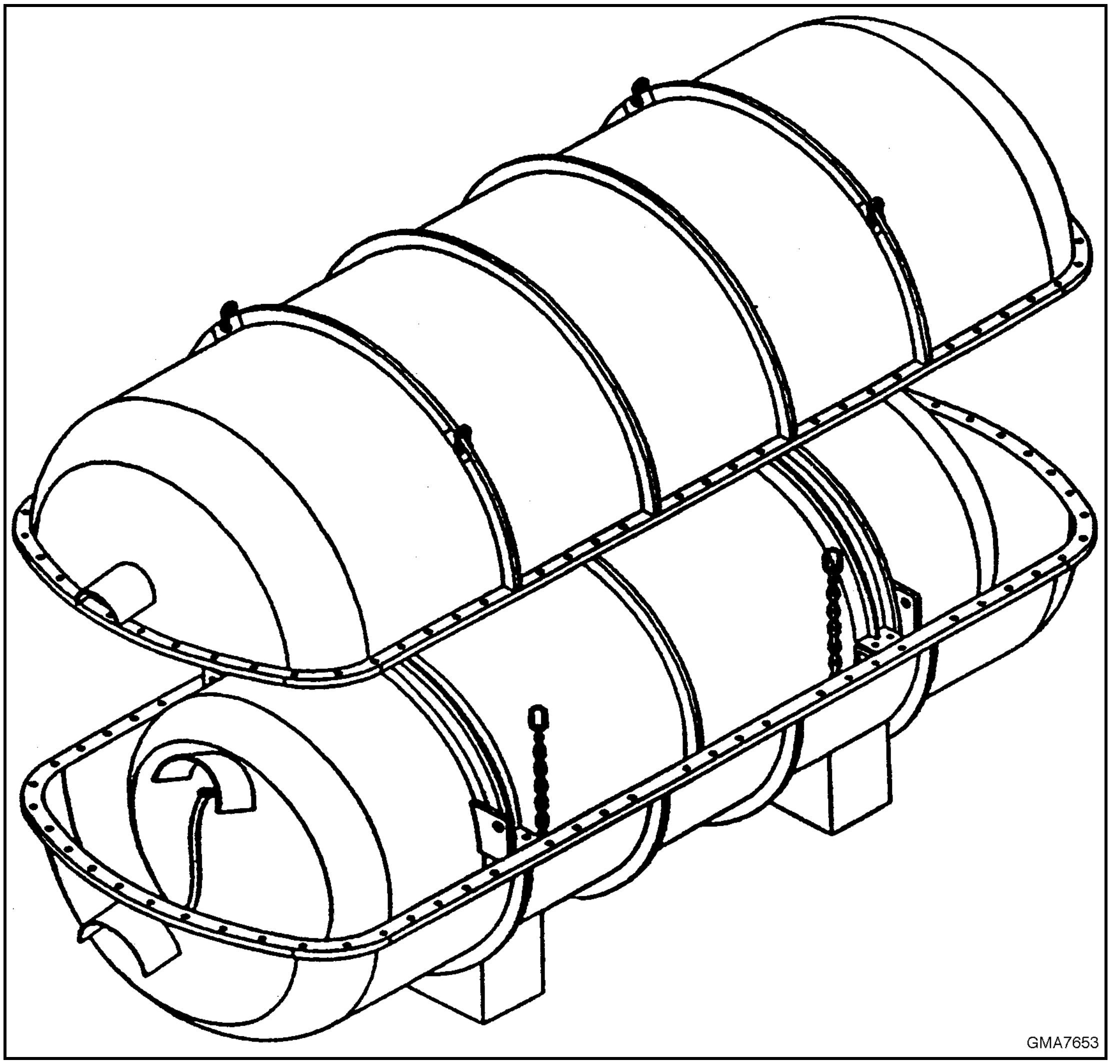

FIGURE 4.1 Horizontal "Clamshell" Overcontainer for Transportation of Cylinders Not Meeting DOT Requirements (Source: LLNL 1997)

4.2.2 Cylinder Transfer

A second option for transporting cylinders that do not meet DOT requirements would be to transfer the depleted UF_6 from substandard cylinders to new cylinders that meet all DOT requirements. This option would require the construction of a new facility. A representative transfer facility is shown in Figure 4.2. The transfer facility would be a stand-alone facility capable of receiving cylinders, storing a small number of cylinders, and transferring the contents to new cylinders. The transfer of depleted UF_6 would take place in a process building by placing substandard cylinders into autoclaves. The autoclaves would be used to heat the contents of the cylinder (using hot air), forming UF_6 gas which then would be piped to a new cylinder. The new cylinders could be shipped by placing them directly on appropriate trucks or railcars. The empty cylinders would be cleaned and treated with other scrap metals. (See Section 5 for details on the treatment of empty cylinders.)

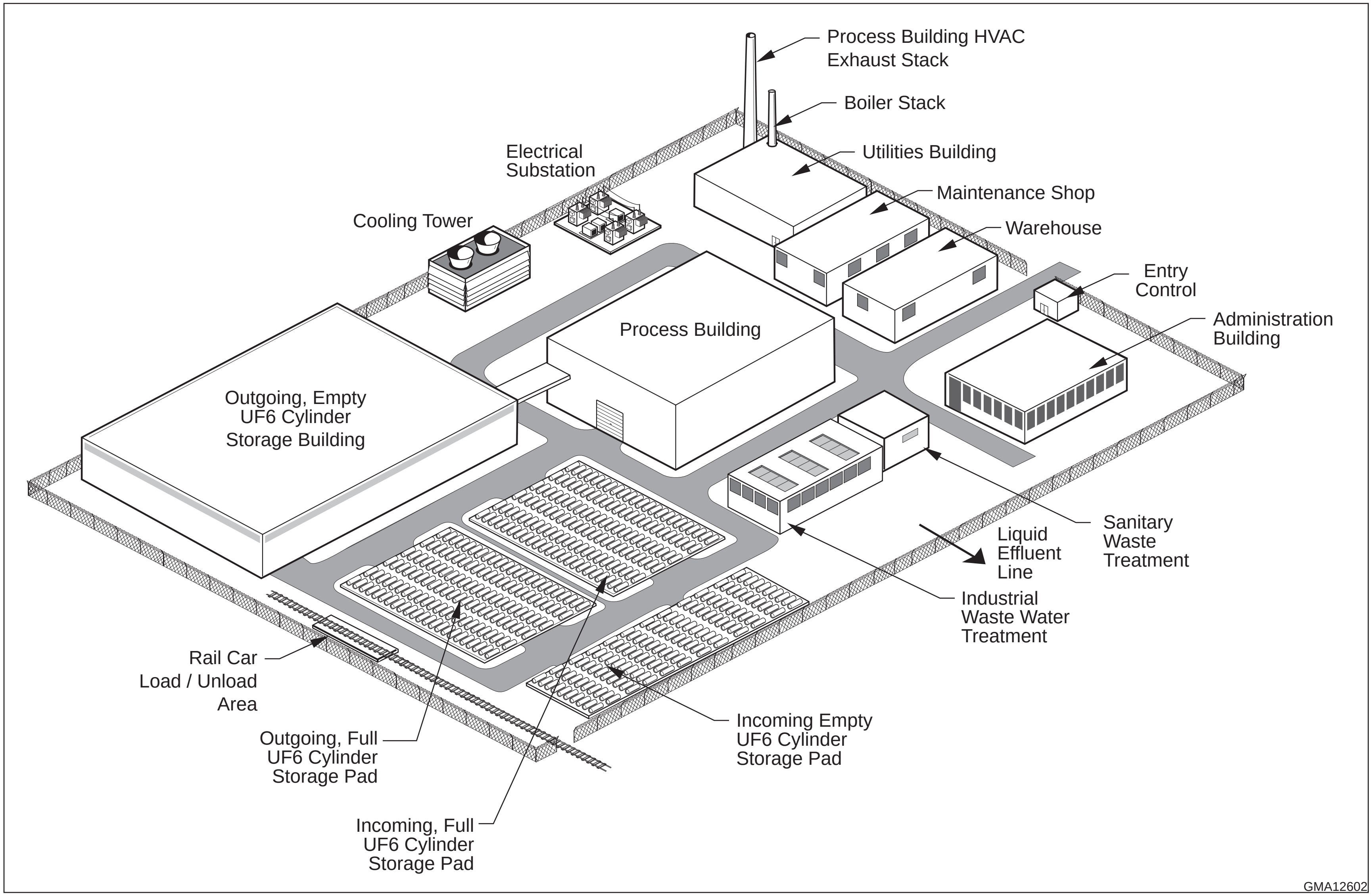

FIGURE 4.2 Representative Layout of a Transfer Facility Site (Source: LLNL 1997)

4.3 IMPACTS OF OPTIONS

This section provides a summary of the potential environmental impacts associated with the cylinder preparation options, including impacts from construction (of a cylinder transfer facility), and during operations. Information related to the assessment methodologies for each area of impact is provided in Appendix C of the PEIS.

The environmental impacts from the cylinder preparation options were evaluated on the basis of the information described in the engineering analysis report (LLNL 1997) and Folga (1996a). The following general assumptions apply to the assessment of impacts:

- The assessment considers preparation of cylinders that meet DOT requirements (standard cylinders), as well as those cylinders that do not meet the requirements.

- Evaluation of standard cylinder preparation and the cylinder overcontainer option includes only an operational phase — no construction activities would be required. Additionally, these options would not generate emissions of uranium compounds or HF during normal operations.

- The evaluation of the cylinder transfer option includes construction of a facility in addition to operations. The operation of a cylinder transfer facility would involve small releases of uranium compounds and HF as air and water effluents during normal operations.

- Impacts were evaluated assuming a range in annual processing requirements, because the actual number of cylinders that would not meet DOT requirements at the time of shipment cannot be determined. The ranges of problem cylinders are discussed in the opening of this section. The remaining cylinders were assumed to be standard cylinders that could be shipped directly.

- Cylinder preparation activities would take place over a 20-year period, from 2009 through 2028, for all alternatives except the no action alternative, which does not involve cylinder preparation. (When USEC cylinders are considered, activities are assumed to extend about an additional 6 years through 2034; see Section 4.4.)

4.3.1 Human Health — Normal Operations

4.3.1.1 Radiological Impacts

Potential radiological impacts for the cylinder preparation options were assessed for involved workers, noninvolved workers, and the general public. Detailed discussions of the methodologies used in the radiological impact analyses are provided in Appendix C of the PEIS and Cheng et al. (1997).

Impacts to involved workers would result primarily from external radiation and would depend only on the number of cylinders handled. The estimated collective doses to involved workers are presented in Figures 4.3, 4.4, and 4.5 for the overcontainer option, cylinder transfer option, and preparation of standard cylinders, respectively. Because no airborne or waterborne releases of uranium would be generated for the overcontainer option and preparation of standard cylinders, no radiological impacts would be expected to noninvolved workers or members of the general public. Impacts to these two receptors for the cylinder transfer option are presented in Figures 4.6 through 4.9. The ranges of impacts are due to the range in assumed numbers of cylinders handled annually.

In general, impacts for the overcontainer option would be less than those for the cylinder transfer option. The average doses to involved workers for all cylinder preparation activities would be less than 660 mrem/yr, which is less than the regulatory limit of 5,000 mrem/yr (10 CFR Part 835). Exposure of noninvolved workers and members of the general public would be extremely small, less than 3.0×10^{-5} mrem/yr.

4.3.1.1.1 Overcontainer Option

Potential external radiation exposures of involved workers would occur from preshipment inspection, testing, and surveying of cylinders; unstacking and retrieving cylinders; on-site transportation of cylinders by straddle buggy; loading cylinders into overcontainers placed on trucks or railcars; and packaging cylinders. The annual collective dose to involved workers was estimated to be approximately 2.4 to 12.2 person-rem/yr for about 5 to 22 workers at the Portsmouth site. Assuming that the workers would work 5 hours per day with an availability factor of 75%, i.e., 3.75 hours per day for cylinder preparation activities (Folga 1996c), the average individual involved worker dose would be approximately 540 mrem/yr. The corresponding average cancer risk would be approximately 0.0002 per year (i.e., an individual's chance of developing a latent fatal cancer would be less than 1 in 5,000 per year).

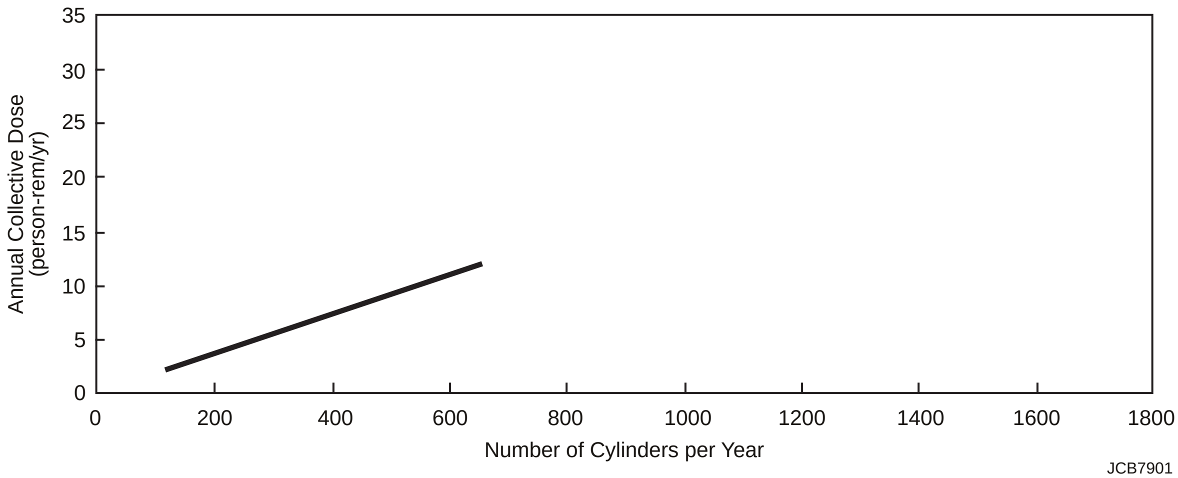

FIGURE 4.3 Annual Collective Dose to Involved Workers from Preparing Problem Cylinders for Shipment Using Overcontainers

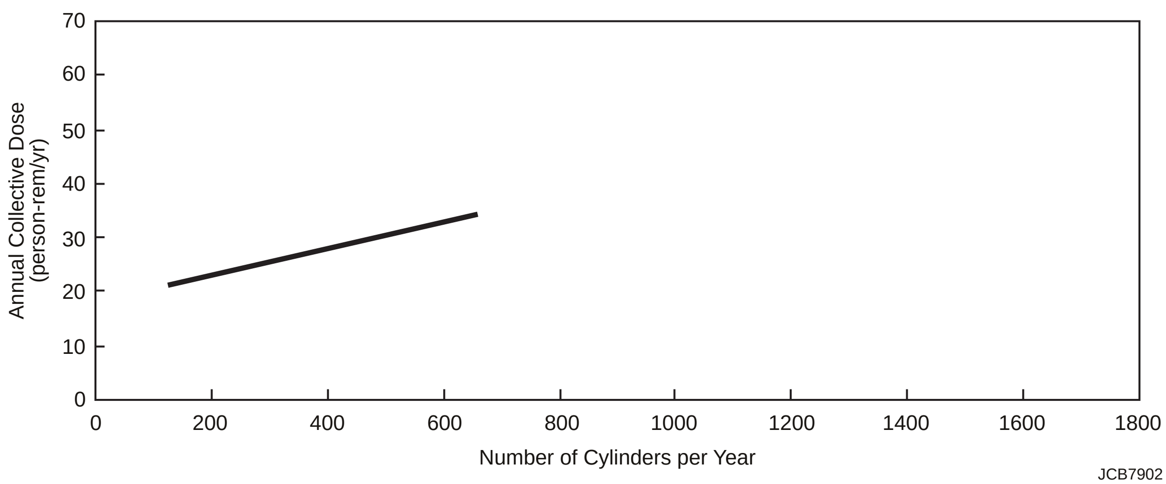

FIGURE 4.4 Estimated Annual Collective Dose to Involved Workers from Preparing Problem Cylinders for Shipment Using the Cylinder Transfer Technology

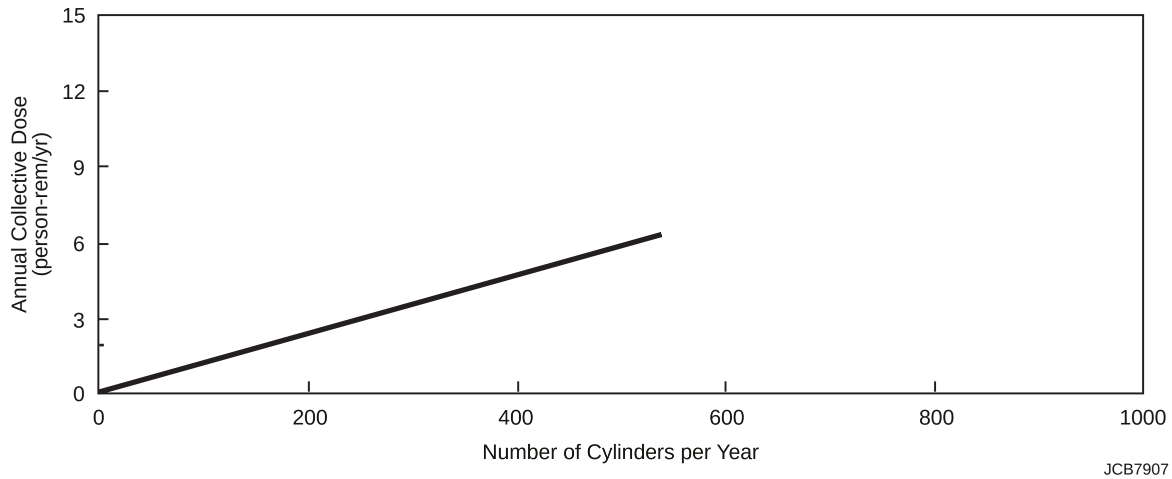

FIGURE 4.5 Annual Collective Dose to Involved Workers from Preparing Standard Cylinders for Shipment

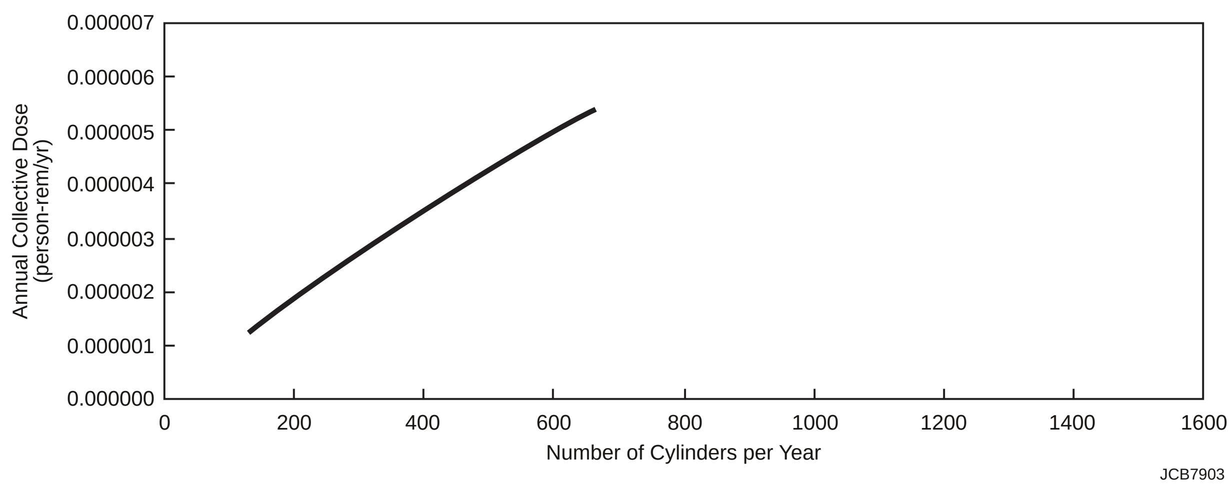

FIGURE 4.6 Estimated Annual Collective Dose to Noninvolved Workers from Preparing Problem Cylinders for Shipment Using the Cylinder Transfer Technology (population size of noninvolved workers: 2,700 at Portsmouth)

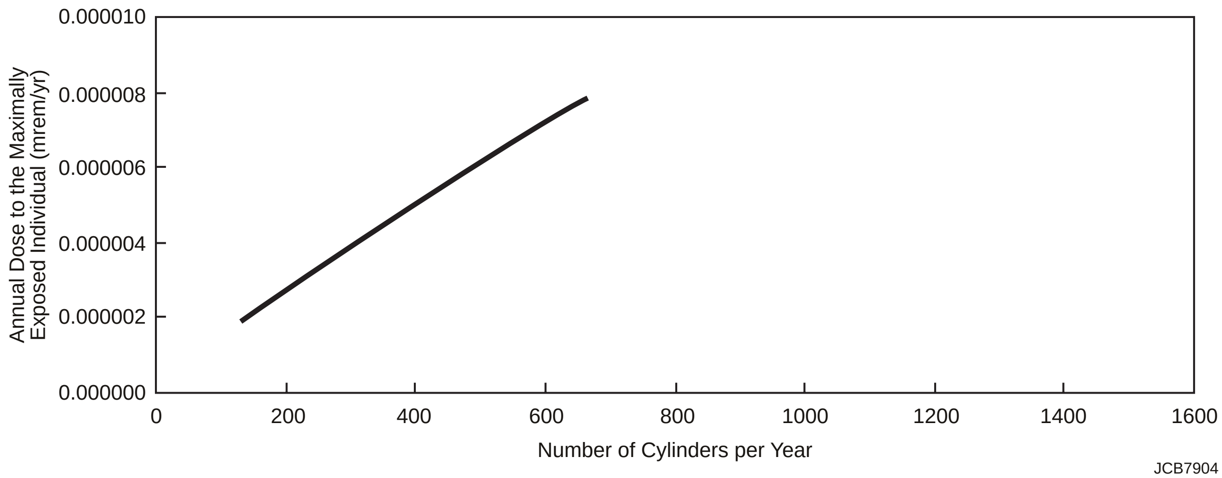

FIGURE 4.7 Estimated Annual Dose to the Noninvolved Worker MEI from Preparing Problem Cylinders for Shipment Using the Cylinder Transfer Technology

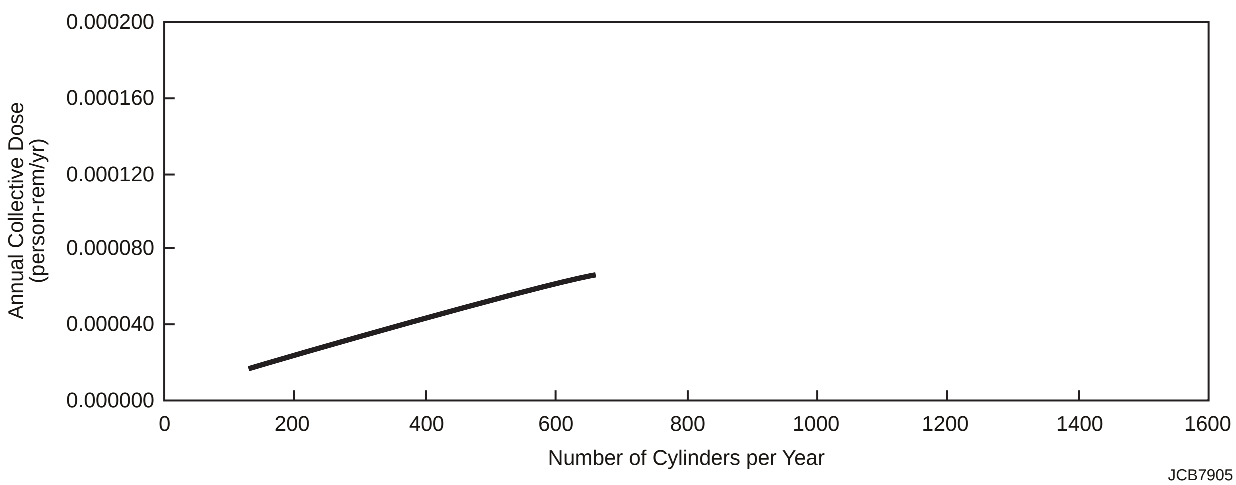

FIGURE 4.8 Estimated Annual Collective Dose to the General Public from Preparing Problem Cylinders for Shipment Using the Cylinder Transfer Technology (exposure would result from airborne emissions; population size of general public: about 605,000 at Portsmouth)

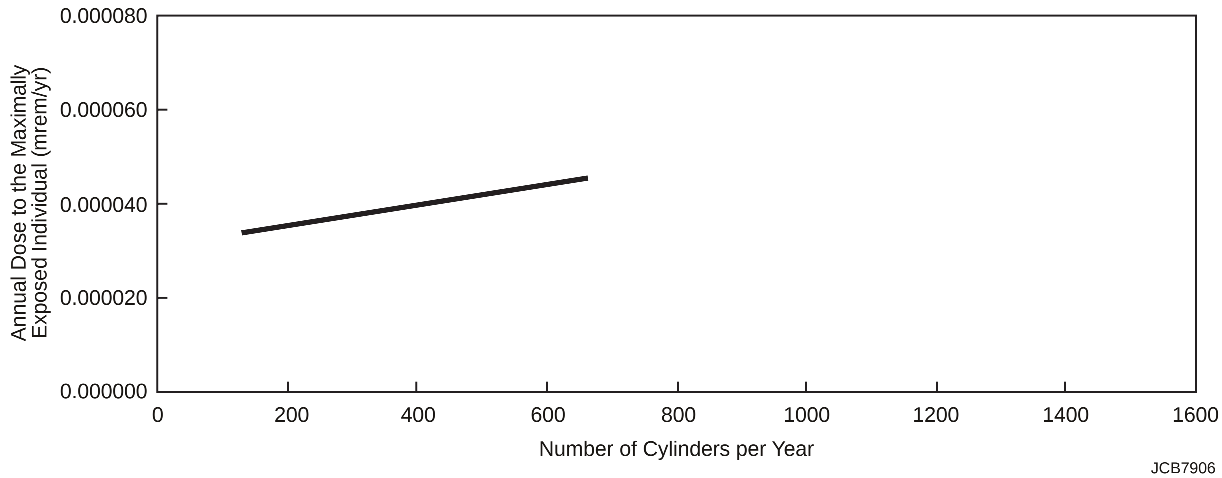

FIGURE 4.9 Estimated Annual Dose to the General Public MEI from Preparing Problem Cylinders for Shipment Using the Cylinder Transfer Technology (exposures would result from airborne emissions and discharge of wastewater)

4.3.1.1.2 Cylinder Transfer Option

The collective dose to involved workers would range from 21 to 34 person-rem/yr for approximately 32 to 62 workers at the Portsmouth site. The average individual dose to involved workers would be less than 660 mrem/yr, corresponding to a risk of LCF of 3×10^{-4} per year (one chance in 3,300 per year).

Radiation doses to noninvolved workers vary depending on the processing rate of cylinders, site-specific meteorological conditions, and distribution and population of the on-site workers (for collective doses). The estimated radiation dose to the MEI would be extremely small, less than 8×10^{-6} mrem/yr, due to the small airborne emission rates of uranium. Impacts to the off-site public would also depend on the factors discussed for noninvolved workers, but instead of the distribution and population of the on-site workers, the impacts would be determined by the distribution and population of the off-site public (for collective dose).

The radiation dose to the MEI of the off-site public would be greater than that for the MEI of the noninvolved workers because of the assumed additional exposure from drinking surface water. The radiation dose from drinking surface water would be greater than that from airborne emissions. The radiation doses to the off-site public MEI from normal operations of the cylinder transfer facility were estimated to be less than 4.4×10^{-5} mrem/yr, which is extremely small compared with the regulatory limit of 100 mrem/yr.

4.3.1.1.3 Preparation of Standard Cylinders

At the Portsmouth site, the collective radiation doses to involved workers were estimated to range from 0 to 6.2 person-rem/yr. The lower end of the range results from the assumption that all cylinders at the site would be problem cylinders. A maximum of 11 workers would be required for the preparation activities. The average individual dose to involved workers was estimated to be less than 600 mrem/yr.

4.3.1.2 Chemical Impacts

The only potential chemical impacts that could be associated with cylinder preparation options would be from exposure to emissions from a cylinder transfer facility; no impacts during normal operations would be expected for the cylinder overcontainer option or preparation of standard cylinders because no releases would occur. Risks from normal operations were quantified on the basis of calculated hazard indices. Information on the exposure assumptions, health effects assumptions, reference doses, and calculational methods used in the chemical impact analysis is provided in Appendix C of the PEIS and Cheng et al. (1997).

During cylinder transfer operations, very small quantities of UO_2F_2 effluent would be discharged into the air and surface water. Estimates of the hazardous chemical human health impacts resulting from cylinder transfer operations were calculated for the range of cylinders that might require processing (i.e., up to 670 annually at Portsmouth). Inhalation of HF was not included in the hazard index calculations because HF emissions from the cylinder transfer facility would be hundreds of times lower than HF emissions from conversion facilities (see Section 5), for which no chemical impacts were predicted.

No impacts to noninvolved workers or the general public would be expected from normal transfer facility operations. The maximum (high case) hazard index for chemical impacts to the noninvolved worker MEI working at the cylinder transfer facility would be less than or equal to 3.0×10^{-8} at the Portsmouth site. This value is considerably below the threshold for adverse effects (i.e., the ratio of intake to reference dose is much less than 1). The maximum (high case) hazard index for chemical impacts to the general public MEI would be less than or equal to 6.1×10^{-6} at the Portsmouth site; this value is also considerably below the threshold for adverse effects.

4.3.2 Human Health — Accident Conditions

A range of accidents covering the spectrum of high-frequency/low-consequence accidents to low-frequency/high-consequence accidents has been presented in the engineering analysis report (LLNL 1997). These accidents are listed in Table 4.2. The results for the radiological and chemical health impacts of the maximum-consequence accident in each frequency category are presented in Sections 4.3.2.1 and 4.3.2.2. The bounding accidents are the same for both the cylinder overcontainer option and the cylinder transfer option. Results for all accidents listed in Table 4.2 are presented in

TABLE 4.2 Accidents Considered for the Cylinder Preparation Options

Option/Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Cylinder Overcontainers					
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in. deep water pool.	HF	150	60 (continuous)	Ground
Vehicle-induced fire, three full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground
Incredible Accidents (frequency: less than 1 time in 1 million years)					
Small plane crash, two full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,190	0 to 30 30 to 121	Ground
Cylinder Transfer					
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Cylinder valve shear	A single UF_6 cylinder is mishandled, etc., resulting in shearing of the cylinder valve and loss of solid UF_6 from the valve onto the ground.	UF_6	0.25	120 (continuous)	Ground
UF_6 vapor leak	A UF_6 transfer line leaks 5% of its flowing contents for 10 minutes due to potential compressor or pipe leakage.	UO_2F_2 HF	0.009 2.4	30	Stack
UF_6 liquid leak	A drain line from the UF_6 condensers leaks 5% of its flowing contents due to potential condenser or pipe leakage.	UO_2F_2 HF	0.0045 1.2	30	Stack
Loss of off-site electrical power	Off-site power is lost, which halts facility operations but does not result in significant releases to the environment.	No release	NA	NA	NA
Loss of cooling water	Cooling water flow to the UF_6 condenser is lost, and UF_6 vapor is released.	UO_2F_2 HF	0.009 2.4	2	Stack

TABLE 4.2 (Cont.)

Option/Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Cylinder Transfer (Cont.)					
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
UF_6 cold trap rupture	A UF_6 cold trap is overfilled with UF_6 and ruptures during heating, releasing UF_6 into the process building.	UO_2F_2 HF	0.13 34	30	Stack
Extremely Unlikely Accidents (frequency: from 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in. deep water pool.	HF	150	60 (continuous)	Ground
Vehicle-induced fire, three full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground
Earthquake	A UF_6 compressor discharge pipe is cleanly sheared during a design-basis earthquake and leaks for 1 minute.	UO_2F_2 HF	0.018 4.7	30	Stack
Tornado	A design-basis tornado does not result in significant releases because UF_6 is a solid at ambient conditions.	No release	NA	NA	NA
Incredible Accidents (frequency: less than 1 in 1 million years)					
Flood	The facility would be located at a site that would preclude flooding.	No release	NA	NA	NA
Small plane crash, two full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,192	0 to 30 30 to 121.4	Ground

[a] Ground-level releases were assumed to occur outdoors on concrete pads in the cylinder storage yards. To prevent contaminant migration, cleanup of residuals was assumed to begin immediately after the release was stopped.

Policastro et al. (1997). Detailed descriptions of the methodology and assumptions used in these calculations are also provided in Appendix C of the PEIS and Policastro et al. (1997).

4.3.2.1 Radiological Impacts

Table 4.3 lists the radiological doses to various receptors for the accidents that give the highest dose from each frequency category. The LCF risks for these accidents are given in Table 4.4. The doses and the risks are presented as ranges (maximum and minimum) because two different meteorological conditions were considered for each cylinder preparation option (see Appendix C of the PEIS). The doses and risks presented here were obtained by assuming that the accidents would occur. The probability of occurrence for each accident is indicated by the frequency category to which it belongs. For example, accidents in the extremely unlikely category have a probability of occurrence between 1 in 10,000 and 1 in 1 million in any 1 year. The following conclusions may be drawn from the radiological health impact results:

- No cancer fatalities would be predicted from any of the accidents.

- The maximum radiological dose to noninvolved worker and general public MEIs (assuming an accident occurred) would be 0.077 rem. This dose is less than the 25-rem dose recommended by the NRC (1994) for assessing the adequacy of protection of public health and safety from potential accidents.

- The overall radiological risk to noninvolved worker and general public MEI receptors (estimated by multiplying the risk per occurrence [Table 4.4] by the annual probability of occurrence by the number of years of operation) would be less than 1 for all of the accidents.

4.3.2.2 Chemical Impacts

The accidents considered for the cylinder preparation options are listed in Table 4.2. The results of the accident consequence modeling for chemical impacts are given in Tables 4.5 and 4.6. The results are presented as the (1) number of persons with potential for adverse effects and (2) the number of persons with potential for irreversible adverse effects. The results are given for the accident within each accident frequency category that would affect the largest number of persons (total of workers and off-site population) (Policastro et al. 1997). The impacts presented here are based on the assumption that the accidents would occur. The accidents listed in Tables 4.5 and 4.6 are not identical because an accident with the largest impacts for adverse effects might not lead to

TABLE 4.3 Estimated Radiological Doses per Accident Occurrence for the Cylinder Overcontainer and Cylinder Transfer Options at the Portsmouth Site

		Maximum Dose[c]				Minimum Dose[c]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[a]	Frequency Category[b]	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)
Corroded cylinder spill, dry conditions	L	7.7×10^{-2}	2.2	2.2×10^{-3}	2.1×10^{-1}	3.3×10^{-3}	9.5×10^{-2}	9.3×10^{-5}	2.8×10^{-2}
UF_6 cold trap rupture[d]	U	1.0×10^{-7}	1.5×10^{-4}	1.1×10^{-7}	7.1×10^{-4}	2.1×10^{-8}	1.5×10^{-5}	8.6×10^{-8}	2.5×10^{-4}
Vehicle-induced fire, 3 full 48G cylinders	EU	2.0×10^{-2}	1.6×10^{1}	1.3×10^{-2}	3.2×10^{1}	3.7×10^{-3}	2.0	1.9×10^{-3}	1.6
Small plane crash, 2 full 48G cylinders	I	6.6×10^{-3}	5.3	4.3×10^{-3}	5.5×10^{-1}	8.7×10^{-4}	6.9×10^{-1}	6.2×10^{-4}	7.6×10^{-2}

[a] The bounding accident chosen to represent each frequency category is the one that would result in the highest dose to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[b] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations ($> 10^{-2}$/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations ($10^{-2} – 10^{-4}$/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} – 10^{-6}$/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations ($< 10^{-6}$/yr).

[c] Maximum and minimum doses reflect differences in assumed meteorological conditions at the time of the accident. In general, maximum doses would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum doses would occur under D stability with 4 m/s wind speed.

[d] Applicable only to the cylinder transfer option.

TABLE 4.4 Estimated Radiological Health Risks per Accident Occurrence for the Cylinder Overcontainer and Cylinder Transfer Options at the Portsmouth Site[a]

		Maximum Risk[d] (LCFs)				Minimum Risk[d] (LCFs)			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[b]	Frequency Category[c]	MEI	Population	MEI	Population	MEI	Population	MEI	Population
Corroded cylinder spill, dry conditions	L	3×10^{-5}	9×10^{-4}	1×10^{-6}	1×10^{-4}	1×10^{-6}	4×10^{-5}	5×10^{-8}	1×10^{-5}
UF_6 cold trap rupture[e]	U	4×10^{-11}	6×10^{-8}	6×10^{-11}	4×10^{-7}	8×10^{-12}	6×10^{-9}	4×10^{-11}	1×10^{-7}
Vehicle-induced fire, 3 full 48G cylinders	EU	8×10^{-6}	6×10^{-3}	6×10^{-6}	2×10^{-2}	1×10^{-6}	8×10^{-4}	1×10^{-6}	8×10^{-4}
Small plane crash, 2 full 48G cylinders	I	3×10^{-6}	2×10^{-3}	2×10^{-6}	3×10^{-4}	3×10^{-7}	3×10^{-4}	3×10^{-7}	4×10^{-5}

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (LCF) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.0001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one that would result in the highest risk to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum risks reflect differences in assumed meteorological conditions at the time of the accident. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] Applicable only to the cylinder transfer option.

TABLE 4.5 Number of Persons with Potential for Adverse Effects from Accidents under the Cylinder Overcontainer and Cylinder Transfer Options at the Portsmouth Site[a]

		Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[b]	Frequency Category[c]	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Corroded cylinder spill, dry conditions	L	Yes	48	Yes[f]	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	850	Yes	12	Yes	2	Yes[f]	0
Vehicle-induced fire, 3 full 48G cylinders	EU	Yes	1,000	Yes	650	Yes	160	Yes	4
Small plane crash, 2 full 48G cylinders	I	Yes	700	Yes	22	No	0	No	0

a Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

b The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site people) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

c Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

d Maximum and minimum risks reflect different meteorological conditions at the time of the accident. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

e At the MEI location, the determination is either “Yes” or “No” for potential adverse effects to an individual.

f MEI locations were evaluated at 100 m from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the actual worker and general public population distributions were used, which did not show receptors at the MEI locations.

TABLE 4.6 Number of Persons with Potential for Irreversible Adverse Effects from Accidents under the Cylinder Overcontainer and Cylinder Transfer Options at the Portsmouth Site[a]

		Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Accident[b]	Frequency Category[c]	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Corroded cylinder spill, dry conditions	L	Yes[g]	0	No	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	90	Yes	1	Yes[g]	0	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	110	Yes	1	Yes[g]	0	No	0
Small plane crash, 2 full 48G cylinders[f]	I	No	0	No	0	No	0	No	0

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site population) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum risks reflect different meteorological conditions at the time of the accident. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either "Yes" or "No" for potential irreversible adverse effects to an individual.

[f] These accidents would result in the largest plume size for the frequency category, although no people would be affected.

[g] MEI locations were evaluated at 100 m from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the actual worker and general public population distributions were used, which did not show receptors at the MEI locations.

the largest impacts for irreversible adverse effects. The following general conclusions may be drawn from the chemical accident assessment:

- If the accidents identified in Tables 4.5 and 4.6 did occur, the number of persons in the off-site population with potential for adverse effects would range from 0 to 650 (maximum corresponding to the vehicle-induced fire scenario), and the number of off-site persons with potential for irreversible adverse effects would range from 0 to 1 (maximum corresponding to the corroded cylinder spill with pooling scenario).

- If the accidents identified in Tables 4.5 and 4.6 did occur, the number of noninvolved workers with potential for adverse effects would range from 0 to 1,000 (maximum corresponding to the vehicle-induced fire scenario), and the number of noninvolved workers with potential for irreversible adverse effects would range from 0 to 110 (maximum corresponding to the corroded cylinder spill with pooling scenario).

- Accidents resulting in a vehicle-induced fire involving three 48G cylinders during very stable (nighttime) meteorological conditions would have a very low probability of occurrence but could affect a large number of people.

- The maximum risk was computed as the product of the consequence (number of people) times the frequency of occurrence (per year) times the number of years of operations (20 years, 2009–2028). The results indicate that the maximum risk values would be less than 1 for all accidents, except the following:

  – *Potential Adverse Effects and Irreversible Adverse Effects:*

    Corroded cylinder spill, dry conditions (L, likely), workers

    Corroded cylinder spill, wet conditions – rain (U, unlikely), workers.

These risk values are conservative because the numbers of people affected were based on assuming (1) meteorological conditions that would result in the maximum reasonably foreseeable plume size (i.e., F stability and 1 m/s wind speed) and (2) wind in the direction that would lead to maximum numbers of individuals exposed for workers or for the general population.

To aid in the interpretation of accident analysis results, the number of fatalities potentially associated with the estimated potential irreversible effects was estimated. All the bounding-case accidents shown in Table 4.6 would involve releases of UF_6 and potential exposure to HF and uranium compounds. These exposures could be high enough to result in death for up to 1% of the persons experiencing irreversible adverse effects (Policastro et al. 1997). This would mean that for workers experiencing a range of 0 to 110 irreversible adverse effects, approximately 0 to 1 deaths would be expected. Similarly, of the general public experiencing a range of 0 to 1 irreversible adverse effects, less than 1 death would be expected. These are the maximum potential consequences of the accidents; the upper ends of the ranges result from the assumption of worst-case weather conditions, with the wind blowing in the direction where the highest number of people would be exposed.

4.3.2.3 Physical Hazards

The risk of on-the-job fatalities and injuries for involved and noninvolved workers is calculated using industry-specific statistics from the Bureau of Labor Statistics, as reported by the National Safety Council (1995). Construction and manufacturing annual fatality and injury rates were used respectively for the construction and operational phases of the cylinder transfer facility lifetime; manufacturing fatality and injury rates were used for standard cylinder shipping preparation and overcontainer activities.

Figure 4.10 shows the fatality and injury incidences for all workers associated with packaging cylinders in overcontainers across the ranges that might be required (i.e., 130 to 670 cylinders/yr). The impacts would increase directly as a function of the numbers of cylinders placed in overcontainers annually. Fatality incidences over the 20-year period of operations would all be less than 1 — ranging from about 0.007 to 0.041. On the basis of the ranges given for overcontainer requirements, the corresponding estimated injury incidence over the 20-year operations period would be from about 10 to 54.

Figures 4.11 and 4.12 give the fatality and injury incidences for all workers associated with transferring cylinder contents to new cylinders. It was assumed that any transfer facility would be constructed with a capacity near to or somewhat greater than the maximum number of cylinders expected to require processing (the actual numbers would not be determined until the time of cylinder shipment). However, data in the engineering analysis report (LLNL 1997) also showed that the relationship between the number of cylinders processed annually and number of employees required per cylinder processed would not increase linearly. For example, more employees per cylinder would be required to process 100 cylinders than to process 1,000 cylinders. Fatality incidence for transfer facility construction and operation would be less than 1, ranging from about 0.22 to 0.31. The corresponding injury incidence would range from about 110 to 240.

Figure 4.13 gives the fatality and injury incidences for all workers associated with preparation of standard cylinders for transport across the range that might be required at the Portsmouth site (i.e., from 0 to 540 cylinders/yr). The impacts would increase directly as a function of the numbers of cylinders prepared annually. Fatality incidence would be less than 1, ranging from 0 to about 0.025. The corresponding injury incidence would range from 0 to about 33.

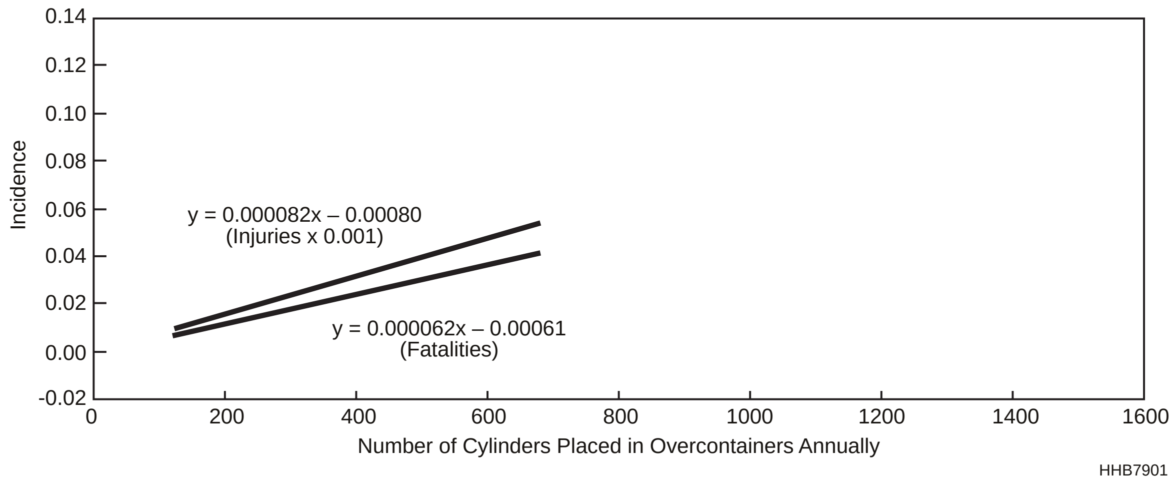

FIGURE 4.10 Worker Fatality and Injury Incidence for Cylinder Overcontainer Activities

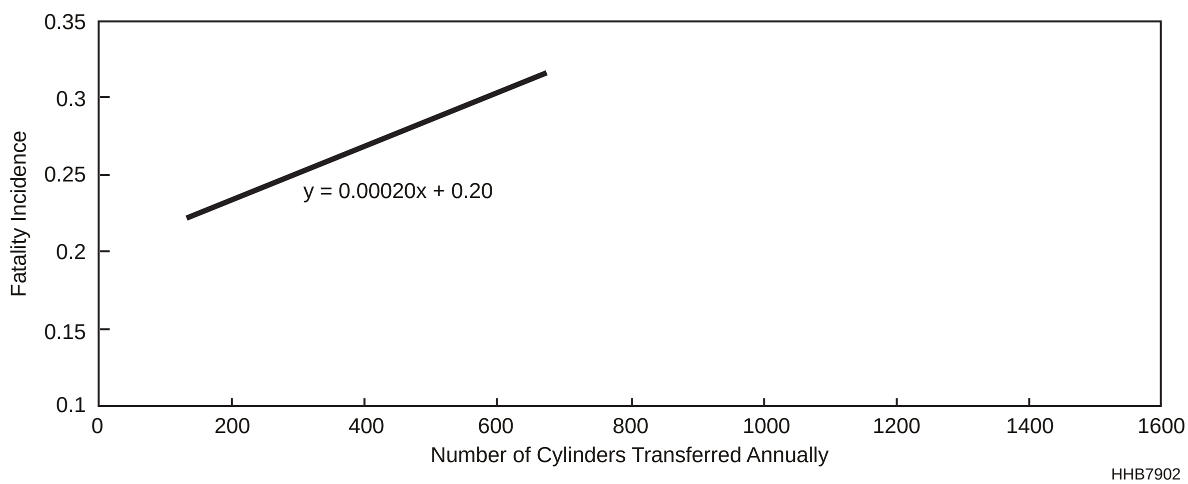

FIGURE 4.11 Worker Fatality Incidence for Cylinder Transfer Activities

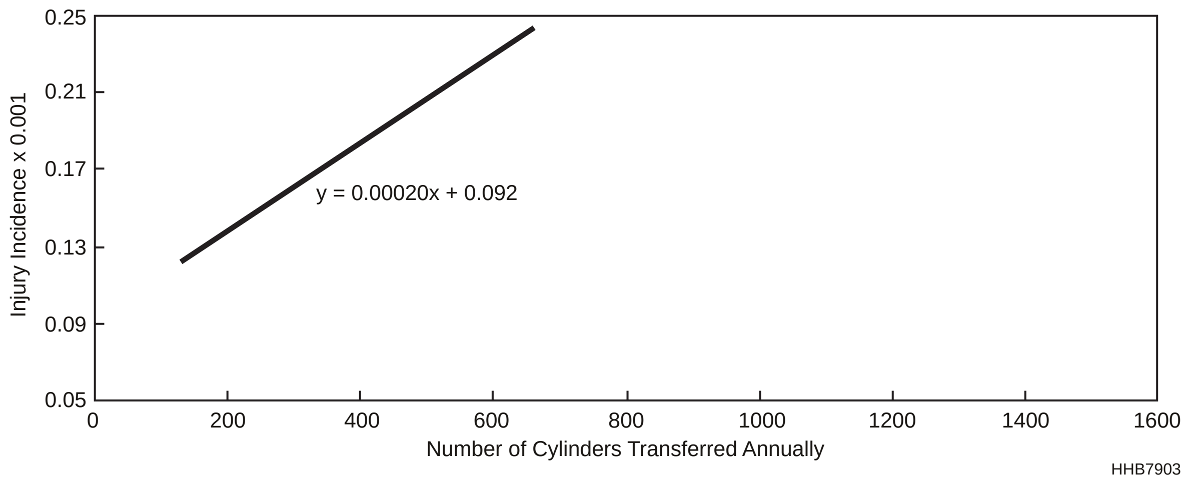

FIGURE 4.12 Worker Injury Incidence for Cylinder Transfer Activities

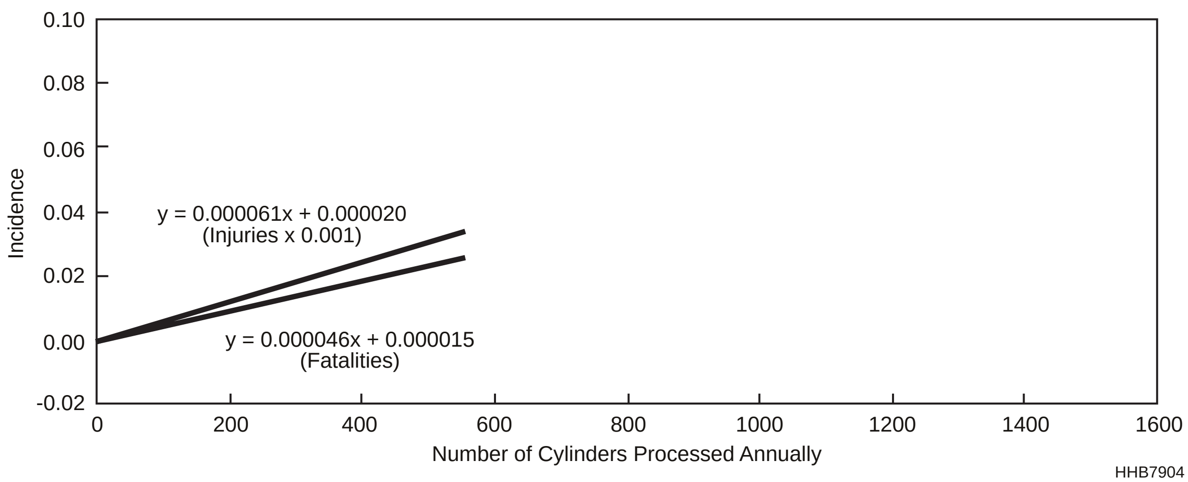

FIGURE 4.13 Worker Fatality and Injury Incidence for Standard Cylinder Preparation

4.3.3 Air Quality

Air quality impacts would result from the emissions associated with two distinct cylinder preparation options: (1) movement of cylinders in preparation for transportation, both those cylinders requiring overcontainers and standard cylinders, and (2) construction and operation of facilities to transfer contents from substandard cylinders to new ones. These two options are referred to in the following discussion as “overcontainer” and “transfer facility.” No construction would be required for the overcontainer option. Descriptions of the methodology and assumptions are provided in Appendix C of the PEIS and Tschanz (1997a).

The air quality impacts of cylinder preparation options at the Portsmouth site are shown in Table 4.7. All impacts from construction of a transfer facility with a capacity for 960 cylinders per year at the Portsmouth site would be less than applicable air quality standards.

The impacts of criteria pollutant emissions during operation of the transfer facility would be negligible. Process stack emissions during operations would produce an annual average HF concentration of 1.9×10^{-5} : g/m^3 and UO_2F_2 concentration of 1.5×10^{-6} : g/m^3.

No quantitative estimate was made of the impacts on the criterion pollutant ozone. Ozone formation is a regional issue affected by emissions data for the entire area around the Portsmouth site. Pike and Scioto Counties in the Wilmington-Chillicothe-Logan Air Quality Control Region are currently in attainment for all criteria pollutant standards, including ozone. The pollutant emissions most related to ozone formation that could result from the cylinder preparation options at the Portsmouth site would be HC and NO_x. The potential effects on ozone of those emissions can be put in perspective by comparing them with the total emissions of HC and NO_x for point sources in Pike and Scioto Counties, as recorded in the Ohio Environmental Protection Agency “Emissions Inventory” for 1990 (Juris 1996). The estimated HC and NO_x emissions of 0.18 and 1.65 tons/yr from operation of the cylinder transfer facility would be only 0.011 and 0.069%, respectively, of the 1990 two-county emissions totals of those pollutants from inventoried point sources. These small additional contributions to the totals would be unlikely to alter the ozone attainment status of the region. Emissions of HC and NO_x from the overcontainer option would be even smaller.

4.3.4 Water and Soil

The cylinder preparation options were assessed for potential impacts on surface water, groundwater, and soils. Details on the methodology and assumptions are presented in Appendix C of the PEIS and Tomasko (1997b).

TABLE 4.7 Air Quality Impacts of Cylinder Preparation Options at the Portsmouth Site

	Estimated Maximum Pollutant Concentrations from the Overcontainer Option							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
Pollutant	Range (: g/m^3)	Fraction of Standard[a]	Range (: g/m^3)	Fraction of Standard[a]	Range (: g/m^3)	Fraction of Standard[a]	Range (: g/m^3)	Fraction of Standard[a]
CO	5.4 – 7.7	0.00019	0.91 – 1.3	0.00013	0.36 – 0.52	–	0.029 – 0.042	–
NO_x	0.81 – 1.2	–	0.14– 0.20	–	0.054– 0.079	–	0.0044 – 0.0064	0.000064
PM_{10}	0.16 – 0.23	–	0.027 – 0.040	–	0.011 – 0.016	0.00011	0.00088 – 0.0013	0.000026

	Estimated Pollutant Concentrations from Construction of the Cylinder Transfer Facility							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
Pollutant	Concentration (: g/m^3)	Fraction of Standard[a]	Concentration (: g/m^3)	Fraction of Standard[a]	Concentration (: g/m^3)	Fraction of Standard[a]	Concentration (: g/m^3)	Fraction of Standard[a]
CO	2,600	0.065	660	0.066	250	–	29	–
NO_x	390	–	97	–	38	–	4.3	0.043
PM_{10}	560	–	140	–	54	0.36	6.2	0.12

[a] Ratio of the upper end of the concentration range divided by the respective air quality standard. A ratio of less than 1 indicates that the standard would not be exceeded. A hyphen indicates that no standard is available for this averaging period.

4.3.4.1 Surface Water

Potential impacts to surface water for the cylinder preparation options could occur during construction, normal operations, and postulated accident scenarios. For the cylinder overcontainer option and preparation of standard cylinders, however, there would be no impacts to surface water because no liquid wastes would be produced during construction and operations (LLNL 1997) and no accident scenarios were identified in the engineering analysis report that would directly release contaminated material to surface water (LLNL 1997). Secondary impacts to surface water would also be negligible because of the small concentrations associated with air deposition.

For the cylinder transfer facility, potential impacts to surface water during construction, normal operations, and accident scenarios would include changes in runoff, changes in quality, and floodplain encroachment.

4.3.4.1.1 Construction

Construction of a cylinder transfer facility with a capacity of 960 cylinders per year at the Portsmouth site would increase runoff because about 10 acres (4.1 ha) of land would be replaced with paved lots and buildings (Table 4.8). This increase in impermeable surface would produce a negligible impact on runoff because of the size of the existing watershed (0.3% of the land available).

Construction of the cylinder transfer facility would require about 8 million gal/yr of water (15 gpm). Following usual practice at the Portsmouth site, this water would be withdrawn from wells, and there would be no impact to surface water. During construction, about 4 million gal/yr (8 gpm) of wastewater would be discharged to the river. Because of dilution (260,000:1), contaminant concentrations would be reduced to considerably below regulatory standards.

4.3.4.1.2 Operations

For normal operations of the 960/yr cylinder transfer facility at the Portsmouth site, about 7 million gal/yr (13 gpm) of water would be required (Table 4.8). Because this water would be withdrawn from wells, there would be no surface water impacts.

About 5.7 million gal/yr (11 gpm) of wastewater would be discharged to the river. This water would consist of sanitary wastewater, blowdown water, industrial wastewater, and process water (LLNL 1997). This discharge would represent about 0.00052% of the average river flow and would produce a negligible impact on water levels and floodplains.

Normal operations would also impact surface water quality. Approximately 0.00063 Ci/yr of uranium would be released to surface water (about 112 : g/L at the point of discharge). Although the concentration of uranium at the outfall would exceed the 20 : g/L guideline (EPA 1996), the resulting uranium concentration (as well as other chemicals) in the river would be less 20 : g/L because of dilution (200,000:1).

4.3.4.1.3 Accident Scenarios

No accidents were identified in LLNL (1997) that would directly affect surface water at any of the three storage sites. Secondary impacts resulting from deposition of airborne contaminants would not be measurable because of low concentrations in the deposited material.

TABLE 4.8 Summary of Environmental Parameters for the Cylinder Transfer Facility

Option	Amount Involved
Disturbed land area (acres)	14
Paved area (acres)	10
Construction water (million gal/yr)	8
Construction wastewater (million gal/yr)	4
Operations water (million gal/yr)	7
Operations wastewater (million gal/yr)	5.7
Radioactive release (Ci/yr)	0.00063

4.3.4.2 Groundwater

For the cylinder overcontainer option and during preparation of standard cylinders, there would be no impacts to groundwater because there would be no discharges to the surface (LLNL 1997). For the cylinder transfer facility, impacts could occur during construction and normal operations; however, there would be no impacts from potential accidents because no accidents were identified in the engineering analysis report (LLNL 1997) that would release contaminants to the ground. Secondary impacts from air deposition would not be measurable because of the small concentrations of deposited material.

4.3.4.2.1 Construction

Construction of the cylinder transfer facility at the Portsmouth site would decrease the permeability of about 10 acres (4.1 ha) (Table 4.8). This loss of permeable land would reduce recharge, increase depth to the water table, and change the direction of groundwater flow; however, because the affected area would be small (about 0.3% of the land available), the impacts would be local and negligible.

Construction of the cylinder transfer facility would require extracting 4 million gal/yr (8 gpm) from wells. This extraction would increase the daily withdrawal by less than 0.1% and would produce a negligible impact on depth to groundwater and direction of groundwater flow.

Construction could also impact groundwater quality. By following good engineering and construction practices, groundwater concentrations would be less than the EPA guidelines.

4.3.4.2.2 Operations

Normal operation of the cylinder transfer facility at the Portsmouth site would require an additional 7 million gal/yr of withdrawal from wells (Table 4.12). This rate of withdrawal would represent an increase in daily extraction of about 0.1%. Because the rate of increased use would be small, impacts to the depth to the groundwater and its flow direction would be negligible. No impacts would occur to groundwater quality because there would be no direct discharges to the ground.

4.3.4.2.3 Accident Scenarios

No accidents associated with cylinder preparation options were identified in LLNL (1997) that would potentially release contaminants to groundwater.

4.3.4.3 Soil

For the cylinder overcontainer option and during preparation of standard cylinders, there would be no impacts to soils because there would be no discharges to the ground. For the cylinder transfer facility, the only impacts would occur during construction; for normal operations, there would be no discharges to the ground, and there are no accidents identified in the engineering analysis report (LLNL 1997) that would lead to direct contamination of the soil. Secondary impacts to the soil from air deposition would be negligible because of the small concentrations of contaminants in the deposited material. Impacts from construction of the cylinder transfer facility include changes in topography, permeability, quality, and erosion potential.

At the Portsmouth site, construction of a cylinder transfer facility with a capacity for 960 cylinders per year would disturb 14.3 acres (5.8 ha) of land (Table 4.8). In the area of the construction, topography would be altered, permeability would be decreased in paved areas or areas that were compacted, permeability would increase in aerated areas, and erosion potential would decrease in compacted areas and increase in areas that were aerated. In general, these impacts would be negligible because the affected area would be small (about 0.4% of the land available), and in many cases, the impacts would be temporary (with regrading and reseeding, the soil would return to its former condition).

In addition to these physical changes, construction could also have a chemical impact on soil. By following good engineering and construction practices, impacts to soil quality would be negligible.

4.3.5 Socioeconomics

The impacts of cylinder preparation on socioeconomic activity were estimated for an ROI around the Portsmouth site. Additional details regarding the assessment methodology are presented in Appendix C of the PEIS and Allison and Folga (1997).

Cylinder preparation would likely have a small impact on socioeconomic conditions in the ROI surrounding the site described in Section 2.8. This is partly because a major proportion of expenditures associated with procurement for the preoperation and operation of each preparation option would flow outside the ROI to other locations in the United States, reducing the concentration of local economic effects of the facility.

Slight changes in employment and income would occur in the ROI as a result of local spending of personal consumption expenditures derived from employee wages and salaries, local procurement of goods and services required for cylinder preparation activities, and other local investment associated with preoperations and operations. In addition to creating new (direct) jobs at the site, cylinder preparation would also create indirect employment and income in the ROI as a result of jobs and procurement expenditures at the site. Jobs and income created directly by cylinder preparation, together with indirect activity in the ROI, would contribute slightly to a reduction in unemployment in the ROI. Minimal impacts would be expected on local population growth and, consequently, on local housing markets and local fiscal conditions.

The effects of preoperating and operating cylinder preparation on regional economic activity, measured in terms of employment and personal income, and on population, housing, and local public revenues and expenditures are discussed in Sections 4.3.5.1 through 4.3.5.3. Impacts are presented for cylinder preparation at the Portsmouth site for the peak year of preoperations; operations values are averages for the period 2009 through 2028. The impacts of cylinder preparation are given in Table 4.9.

4.3.5.1 Impacts from Cylinder Preparation Using Overcontainers

During the peak year of preoperation for standard cylinder preparation using overcontainers, fewer than 5 direct jobs would be created at the site and fewer than 5 additional jobs indirectly in the ROI (Table 4.9) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, fewer than 5 jobs would be created. Preoperation activities would also produce direct and indirect income in the ROI surrounding the site, with \$0.2 million of total income produced during the peak year. During the first year of operations involving overcontainers, 180 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with \$7 million in total income produced. Activities associated with overcontainers would result in an increase in the projected baseline compound annual average growth rate in ROI employment of 0.02 percentage points from 1999 through 2028.

TABLE 4.9 Potential Socioeconomic Impacts of the Cylinder Preparation Options at the Portsmouth Site

Parameter	Cylinder Overcontainers		Cylinder Transfer Facility		Standard Cylinder Preparation	
	Preoperation[a]	Operations[b]	Construction[a]	Operations[b]	Preoperation[a]	Operations[b]
Economic activity in the ROI						
Direct jobs	<5	100	190	160	<5	50
Indirect jobs	<5	80	90	180	<5	40
Total jobs	<5	180	280	350	<5	90
Direct income ($ million)	0.1	6	8	8	0.1	3
Total income ($ million)	0.2	7	10	11	0.1	4
Population in-migration into the ROI	<5	200	320	330	<5	100
Housing demand						
Number of units in the ROI	<5	80	120	120	<5	40
Public finances						
Change in ROI fiscal balance (%)	0	0.1	0.2	0.2	0	0.1

[a] Impacts are for peak year of preoperation or construction, 2007. The preoperational (construction) phase was assessed from 1999 through 2008.

[b] Impacts are the annual averages for operations for the period 2009 through 2028.

Preoperations involving overcontainers would be expected to generate direct in-migration of fewer than 5 in the peak year (Table 4.9). Additional indirect job in-migration would also be expected, bringing the total number of in-migrants to fewer than 5 in the peak year. Operational activities for cylinder overcontainers would be expected to generate direct and indirect job in-migration of 200 in the first year of operations. Preoperational and operational activities for overcontainers would result in an increase in the projected baseline compound annual average growth rate in ROI population of 0.01 percentage points from 1999 through 2028.

Cylinder overcontainer activities would generate a demand for fewer than 5 additional rental housing unit during the peak year of preoperations, representing an impact of 0.1% on the projected number of vacant rental housing units in the ROI. A demand for 80 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 1.6% on the number of vacant owner-occupied housing units in the ROI.

During the peak year of preoperations, fewer than 5 people would be expected to in-migrate into the ROI, leading to essentially no increase over ROI-forecasted baseline revenues and expenditures (Table 4.9). In the first year of operations, 200 in-migrants would be expected, leading to an increase of 0.1% in local revenues and expenditures.

4.3.5.2 Impacts from a Cylinder Transfer Facility

During the peak year of construction of a cylinder transfer facility, 190 direct jobs would be created at the site and 90 additional jobs indirectly in the ROI (Table 4.9) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, 280 jobs would be created. Construction activity would also produce direct and indirect income in the ROI surrounding the site, with $10 million of total income produced during the peak year. During the first year of operations of the cylinder transfer facility, 350 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with $11 million in total income produced. Construction and operation of the transfer facility would result in an increase in the projected baseline compound annual average growth rate in ROI employment of 0.03 percentage points from 1999 through 2028.

Construction of the cylinder transfer facility would be expected to generate direct in-migration of 260 in the peak year (Table 4.9). Additional indirect job in-migration would also be expected, bringing the total number of in-migrants to 320 in the peak year. Operation of the cylinder transfer facility would be expected to generate direct and indirect job in-migration of 330 in the first year of operations. Construction and operation of the transfer facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of 0.01 percentage points from 1999 through 2028.

The cylinder transfer facility would generate a demand for 120 additional rental housing units during the peak year of construction, representing an impact of 5.9% on the projected number of vacant rental housing units in the ROI (Table 4.9). A demand for 120 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 0.2% on the number of vacant owner-occupied housing units in the ROI.

During the peak year of construction, 320 people would be expected to in-migrate into the ROI, leading to an increase of 0.2% over ROI-forecasted baseline revenues and expenditures (Table 4.9). In the first year of operations, 330 in-migrants would be expected, leading to an increase of 0.2% in local revenues and expenditures.

4.3.5.3 Impacts from Standard Cylinder Preparation

During the peak year of preoperational activities for standard cylinder preparation, fewer than 5 direct jobs would be created at the site and fewer than 5 additional jobs indirectly in the ROI (Table 4.9) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, fewer than 5 jobs would be created. Preoperational activities would also produce direct and indirect income in the ROI surrounding the site, with $0.1 million of total income produced during the peak year. During the first year of operations for standard cylinder preparation, 90 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with $4 million in total income produced. Preoperational and operational activities for standard cylinder preparation would result in an increase in the projected baseline compound annual average growth rate in ROI employment of 0.01 percentage points from 1999 through 2028.

Preoperational activities for standard cylinder preparation would be expected to generate direct in-migration of fewer than 5 in the peak year (Table 4.9). Additional indirect job in-migration would also be expected, bringing the total number of in-migrants to fewer than 5 in the peak year. Operational activities for standard cylinder preparation would be expected to generate direct and indirect job in-migration of 100 in the first year of operations. Preoperational and operational activities would result in an increase in the projected baseline compound annual average growth rate in ROI population of 0.004 percentage points from 1999 through 2028.

Standard cylinder preparation activities would generate a demand for fewer than 5 additional rental housing units during the peak year of preoperations, representing essentially no impact on the projected number of vacant rental housing units in the ROI (Table 4.9). A demand for 40 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 0.7% on the number of vacant owner-occupied housing units in the ROI.

During the peak year of preoperations, fewer than 5 people would be expected to in-migrate into the ROI, leading to essentially no increase over ROI-forecasted baseline revenues and expenditures (Table 4.9). In the first year of operations, 100 in-migrants would be expected, leading to an increase of 0.1% in local revenues and expenditures.

4.3.6 Ecology

Predicted concentrations of contaminants in environmental media were compared with benchmark values of toxic and radiological effects to assess impacts to terrestrial and aquatic biota. Discussion of assessment methodology is presented in Appendix C of the PEIS.

No ecological impacts would be expected during preparation of standard cylinders. Under the cylinder overcontainer option, no site preparation or construction would occur. Normal operations would not result in impacts to surface water, groundwater, or soil (Section 4.3.4). Atmospheric releases of contaminants would include only criteria pollutants, and emission levels would be expected to be extremely low (Section 4.3.3). Therefore, impacts of the cylinder overcontainer option to ecological resources would be negligible.

Impacts to ecological resources could result from construction of a cylinder transfer facility. Impacts could include mortality of individual organisms, habitat loss, or changes in biotic communities. Impacts due to operation of a cylinder transfer facility could result from exposure to airborne contaminants or contaminants released to soils, groundwater, or surface waters or changes in surface water or groundwater quality or flow rates.

Facility construction would disturb approximately 14 acres (6 ha), including the permanent replacement of 10 acres (4 ha), primarily with structures and paved areas. Construction of the transfer facility would not be expected to threaten the local population of any species. In addition to site-specific surveys for protected species, avoidance of wooded areas would reduce the potential for impacts to the sharp-shinned hawk (state-listed as endangered) and Indiana bat (federal- and state-listed as endangered). The loss of up to 14 acres (6 ha) of undeveloped land and 10 to 14 acres (4 to 6 ha) of habitat would constitute a moderate adverse impact to vegetation and wildlife.

The low atmospheric emissions of contaminants from cylinder preparation activities would result in negligible impacts to biota. Uranium concentrations discharged to surface water would also be low, resulting in negligible impacts to aquatic biota.

4.3.7 Waste Management

Estimates of waste generation were based on the total number of DOE-generated cylinders at the Portsmouth site. No liquid wastes would be expected as a result of cylinder shipment activities from either standard cylinders or cylinders in overcontainers. The only solid waste generated in these activities would be personal protective equipment and wipes and rags that would be used to remove surface contamination on the cylinders. These wastes are categorized as combustible solid LLW and are shown in Table 4.10. It was assumed that the LLW would be generated during removal of surface contamination and would be independent of the cylinders being standard or substandard. Thus, the amount of waste in this operation would be proportional to the number of cylinders. It was assumed that no cylinder breaches would occur inside the overcontainers during transportation.

TABLE 4.10 Waste Generated with Activities for Cylinder Overcontainers or Standard Cylinder Preparation[a]

Waste Type[b]	Waste Generated: Annual Volume (m^3/yr)	Waste Generated: Uranium Form
LLW (combustible solids)	7.0	UO_2F_2

[a] Decontamination of the overcontainer surfaces was assumed to be performed at the conversion/storage facility prior to the overcontainer being sent back to the site for reuse.

[b] It was assumed that the low-level waste would be generated during removal of surface contamination and would be independent of the cylinder being standard or substandard.

The waste input resulting from the cylinder overcontainer operations would have minimal impact on radioactive waste management capabilities at the site or on a national level. The impact on site nonradiological waste management would also be negligible.

The estimated total quantities of solid and liquid wastes generated from activities associated with the construction of the transfer facility with a 960-cylinder/yr capacity are shown in Table 4.11. A facility with this capacity would represent the upper end of the range of cylinders that might require preparation at the Portsmouth site. The type and quantity of solid and liquid waste expected to be generated from the operation of the cylinder transfer facility are shown in Table 4.12, based on an annual throughput cylinder capacity of 5% of the cylinder inventory at the site. The different types of waste generated during the operation of this facility would include LLW, LLMW, hazardous waste, and nonhazardous waste.

TABLE 4.11 Total Wastes Generated during Construction of a Transfer Facility with a 960-Cylinder/Year Capacity

Waste Category	Quantity
Hazardous solids	38 m^3
Hazardous liquids	20,000 gal
Nonhazardous solids	
Concrete	76 m^3
Steel	30 tons
Other	612 m^3
Nonhazardous liquids	
Sanitary	3 million gal
Other	1 million gal

The primary waste produced in the transfer process would be empty UF_6 cylinders and grouted waste drums. Radioactive or hazardous

TABLE 4.12 Estimated Annual Radioactive, Hazardous, and Nonhazardous Wastes Generated during Operation of the Cylinder Transfer Facility at the Portsmouth Site[a]

Type of Waste	Description of Waste	Annual Volume (m^3)	Contaminants
Low-Level Waste			
Combustible solids	Gloves, wipes, clothing, etc.	43	17 lb UO_2F_2
Metal, surface-contaminated	Failed equipment	5.3	16 lb UO_2F_2
Noncombustible compactible solids	HEPA filters	11	54 lb UO_2F_2
	Grouted waste	1.3	135 lb $UO_2(OH)_2$
Other	Lab packs (chemicals)	0.27	0.75 lb UO_2F_2
Low-Level Mixed Waste			
Lab packs	Chemicals	0.13	0.37 lb UO_2F_2
Inorganic process debris	Failed equipment	0.13	0.37 lb UO_2F_2
Combustible debris	Wipes, etc.	0.13	0.07 lb UO_2F_2
Hazardous Waste			
Organic liquids	Solvents, oil, paint, thinner	0.35	
Inorganic process debris	Failed equipment	0.6	1.5 lb HF, 2 lb NaOH
Combustible debris	Wipes, etc.	0.6	0.75 lb HF, 1 lb NaOH
Nonhazardous Waste			
Nonhazardous solid waste	Nonhazardous solid waste	46	
Nonhazardous liquid waste	Cooling tower blowdown process water, etc.	220	
Recyclable waste	Recyclable waste	85	

[a] HEPA = high-efficiency particulate air (filters), HF = hydrogen fluoride, NaOH = sodium hydroxide, UO_2F_2 = uranyl fluoride, $UO_2(OH)_2$ = uranyl hydroxide.

liquid materials would include decontamination liquids, laboratory liquid wastes, contaminated cleaning solution, lubricants, and paints. Radioactive or hazardous solid wastes would include failed process equipment, high-efficiency particulate air (HEPA) filters, laboratory wastes, wipes, rags, and operator-contaminated clothing. The LLW would be shipped off-site for disposal, and the LLMW and hazardous waste would be shipped off-site for both treatment and disposal. The volume of crushed, empty UF_6 cylinders from the Portsmouth site would be about 38,000 m^3. It was assumed that the treated cylinders would become part of the DOE scrap metal inventory. If a disposal decision was made, the treated cylinders could be disposed of as LLW, representing an addition of about 1% to the total projected DOE complexwide LLW disposal volume.

Overall, the waste input resulting from construction and operation of a transfer facility would add less than 7% to the Portsmouth site LLW generation (see Section 2.9). The input of LLMW and nonhazardous wastes from the transfer facility would represent less than 1% of the site's LLMW or nonhazardous waste loads.

The waste input resulting from the construction and operation of the transfer facility would have minimal impact on radioactive waste management capabilities at the site. The impact on nonradiological site waste management would also be negligible. The impacts of waste resulting from the operation of the depleted UF_6 transfer facility on national waste management capabilities would be negligible.

4.3.8 Resource Requirements

The approach taken for assessment of resource requirements was based on a comparison of required resources with available national and state-level statistics on consumption of commodities (U.S. Department of Commerce 1997, 1999). More detailed information related to the methodology is presented in Appendix C of the PEIS.

Cylinder overcontainers would be constructed primarily from steel purchased from existing steel vendors. The preliminary overcontainer design requires approximately 8,000 lb (3,600 kg) of steel per overcontainer (LLNL 1997). Resources would be required only for the construction of overcontainers. No substantial resources would be required for the use of the overcontainers. Because the overcontainers would be reusable, it is estimated that the total number of overcontainers required would be approximately 175 (LLNL 1997). This total assumes a 10% contingency for spares, unforeseen delays, and the few overcontainers that might be needed at the cylinder treatment facility. The total amount of steel required for the overcontainers would be about 1,400,000 lb (630,000 kg). On the basis of the total steel required for construction of overcontainers, no impact on local or national steel availability or production would be expected (Standard & Poor's 1996; U.S. Bureau of the Census 1996). No other materials of significant quantity would be required.

Resource needs for the cylinder transfer facility are presented in Table 4.13 as utilities consumed during construction and operations. The facility was assumed to operate 24 hours per day, 7 days per week, and 292 days per year for an 80% plant availability during operations.

The process equipment would be purchased from equipment vendors. The total quantities of commonly used construction material (i.e., steel) for equipment would be minor as compared to the quantities for construction. The primary specialty material used for equipment fabrication is at most approximately 7 tons of Monel. The material quantities required for construction and operation of the cylinder transfer facility would be minor compared to local and national supplies.

TABLE 4.13 Resource Requirements for Construction and Operation of the Cylinder Transfer Facility at the Portsmouth Site

Material/Resource	Requirement
Construction	
Utilities	
Electricity (GWh)	35
Solids	
Concrete (yd^3)	20,000
Steel (tons)	8,000
Liquids	
Fuel (million gal)	1.5
Gases	
Industrial gases (gal)	4,400
Specialty material (Monel) (tons)	5
Operations	
Utilities	
Electricity (GWh/yr)	10.8
Solids	
Cement (lb)	1,600
Potassium hydroxide (lb)	2,700
Liquids	
Sulfuric acid (lb/yr)	1,400
Hydrochloric acid (lb/yr)	1,300
Sodium hydroxide (lb/yr)	1,100
Liquid fuel (gal/yr)	5,500
Gases	
Natural gas (million scf/yr[a])	35

[a] scf = standard cubic feet.

4.3.9 Land Use

No impacts to land use from cylinder overcontainer operations at the Portsmouth site would be expected. No additional land would be required, and no new construction would be necessary. Existing handling and support equipment would be utilized with no modifications required (LLNL 1997). No off-site traffic impacts would be encountered during operations because the required labor force would not appreciably affect local traffic patterns or flows.

Impacts to land use from the construction and operation of a cylinder transfer facility would be negligible and limited to temporary disruptions to contiguous land parcels and potential minor traffic disruptions from peak year construction activities. Areal requirements would be small (approximately 14 acres or less).

The peak construction labor force for the cylinder transfer facility could result in potential off-site traffic impacts in the vicinity of the site, although such impacts would be negligible and would ease as construction neared completion.

4.3.10 Cultural Resources

No impacts to cultural resources would be expected at the Portsmouth site as a result of the cylinder overcontainer option for cylinder preparation. Impacts could result from the cylinder transfer option during construction of the transfer facility. Specific impacts cannot be determined at this time and would depend on the exact location of a facility within each site and whether eligible cultural resources existed on or near that location. Operation of the transfer facility would not affect cultural resources.

4.3.11 Environmental Justice

The analysis of human health and environmental impacts associated with the cylinder overcontainer operations (Sections 4.3.1 through 4.3.9) indicates that no high and adverse human health effects would be expected at the Portsmouth site during normal operations. Consequently, no particular segment of the population, including minority and low-income persons, would be disproportionately affected. The results of accident analyses for cylinder preparation did not identify high and adverse impacts to the general public (i.e., the risk of accidents, consequence times probability, was less than 1).

The construction and operation of a cylinder transfer facility at the Portsmouth site would not result in disproportionate effects on minority or low-income populations. The analysis of human health effects and environmental impacts associated with a cylinder transfer facility (Sections 4.3.1 through 4.3.9) indicates that no high and adverse human health effects or environmental impacts would be expected.

4.3.12 Other Impacts Considered But Not Analyzed in Detail

Other impacts that could potentially occur if either of the cylinder preparation options was implemented include impacts to the visual environment (e.g., aesthetics), recreational resources, and noise levels, as well as impacts associated with decontamination and decommissioning of the cylinder transfer facilities. These impacts, although considered, were not analyzed in detail for one or more of the following reasons:

- Consideration of these impacts would not contribute to differentiation among the alternatives and therefore would not affect the decisions to be made in the ROD for the PEIS.

- Impacts to the visual environment, recreational resources, and noise levels would be expected to stay the same as they are because cylinder preparation activities would be similar to the cylinder management activities currently ongoing at the site.

4.4 POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED WITH PREPARING THE ENTIRE PORTSMOUTH SITE CYLINDER INVENTORY FOR SHIPMENT OR STORAGE

After the draft PEIS was completed, management responsibility for approximately 2,700 additional cylinders of depleted UF_6 at the Portsmouth site was transferred from USEC to DOE by the signing of two MOAs associated with the privatization of USEC (DOE and USEC 1998a,b). These cylinders are located in the X-745-G yard at the Portsmouth site (see Figure 2.2). To account for uncertainties associated with the number of cylinders that would be transferred from USEC to DOE in the future and to provide a bounding analysis of environmental impacts, the PEIS evaluated the environmental impacts of managing an additional 3,000 cylinders at the Portsmouth site. These analyses are summarized in Chapter 6 of the PEIS; impacts associated with cylinder preparation for the entire Portsmouth site inventory (including USEC-generated cylinders) are summarized here in Section 4.4.2.

4.4.1 Approach Used to Evaluate the Environmental Impacts of Cylinder Preparation for the USEC Cylinders

The number of cylinders that would not meet DOT requirements at the time of shipment is unknown. A probable range of values determined by the current cylinder conditions was assumed for the analyses. To assess the site-specific impacts from the addition of the USEC cylinders, it was assumed that the cylinder preparation options at the Portsmouth site (i.e., preparation of standard cylinders, use of overcontainers, or operation of a cylinder transfer facility) would be extended for about 6 years to accommodate the additional inventory.

4.4.2 Potential Environmental Impacts from Preparation of the Entire Portsmouth Site Cylinder Inventory (DOE- and USEC-Generated Cylinders) for Shipment or Long-Term Storage

4.4.2.1 Human Health and Safety — Normal Operations

4.4.2.1.1 Workers

The annual doses to workers and the general public from cylinder preparation activities would not increase with the addition of the USEC-cylinders, because it is assumed that the length of operations would be increased from 20 to 26 years, rather than increasing the annual activity levels. For cylinder overcontainer options, the total dose to involved workers would increase, to range from 60 to 300 person-rem for the entire cylinder inventory. The corresponding estimated total number of LCFs would range from 0.02 to 0.1. Noninvolved workers would have no radiation exposures associated with the cylinder overcontainer options.

For cylinder transfer options, the involved worker total dose range would increase to a range of 510–830 person-rem. The corresponding estimated total number of LCFs for involved workers would range from 0.2 to 0.3 LCF. For noninvolved workers, the annual dose to the MEI reported in Table 4.1 would not change. The total collective dose to noninvolved workers would increase to a range of 3×10^{-5} to 1×10^{-4} person-rem; total LCFs would range from 1×10^{-8} to 5×10^{-8}.

For preparation of standard cylinders, the involved worker total dose range would increase to a range of 0–150 person-rem; the corresponding total number of LCFs would be 0 to 0.06. There would be no radiation exposures for noninvolved workers associated with preparation of standard cylinders.

No chemical impacts to workers would be associated with the increased cylinder inventory. The estimated maximum hazard index for the noninvolved transfer facility worker MEI of 3×10^{-8} given in Section 4.3.1.2 would not change; this level is far below the threshold level for adverse effects.

4.4.2.1.2 General Public

Members of the general public have no radiation exposures associated with the cylinder overcontainer or standard cylinder preparation options. For cylinder transfer options, the annual dose to the general public MEI reported in Table 4.1 would not change with the addition of the USEC cylinders. The total collective dose to the general public would increase to range from 3.8×10^{-4} to 1.6×10^{-3}; total LCFs would range from 2×10^{-7} to 8×10^{-7}.

No chemical impacts to the general public would be associated with the increased cylinder inventory. The estimated maximum hazard index for the general public MEI of 6.1×10^{-6} given in Section 4.3.1.2 would not change; this level is far below the threshold level for adverse effects.

4.4.2.2 Human Health and Safety — Accident Conditions

4.4.2.2.1 Physical Hazards

The total number of worker fatalities and injuries associated with cylinder overcontainer options for the entire inventory at the Portsmouth site (including USEC cylinders) would range from 0.01 to 0.05 fatalities and from about 10 to 70 injuries. The total numbers associated with cylinder transfer options for the entire inventory would range from 0.27 to 0.38 fatalities and 130 to 290 injuries. For preparation of standard cylinders, fatalities would range from 0 to 0.031, and injuries would range from 0 to 40.

4.4.2.2.2 Accidents Involving Releases of Radiation or Chemicals

For accident consequences, impacts would be the same as those previously discussed for the DOE-generated cylinders (Section 4.3.2), because the types of accidents assessed would involve only a limited amount of material that would be at risk under accident conditions. Although the estimated frequencies of some accidents would increase somewhat in association with the management of the additional USEC-generated cylinders, this increase is not expected to be enough to change the overall expected frequency of specific accidents from the broad ranges used in the PEIS.

4.4.2.3 Transportation

The cylinder overcontainer option is not associated with transportation risks. The only transportation risks associated with a cylinder transfer facility would be from minor amounts of chemicals used at the facility and small amounts of LLW and LLMW generated at the facility. Section J.3.3 of the PEIS has a more detailed discussion of the transportation risks.

4.4.2.4 Air Quality

Impacts to air quality from cylinder preparation options for the total cylinder inventory would be the same as those presented in Section 4.3.3 for the DOE inventory only. This result would occur because air quality impacts are presented as annual impacts, and the size of the facility (for cylinder transfer options) and the annual levels of operations for all options would not increase. The increased inventory would be accommodated through an increased length of operations.

4.4.2.5 Water and Soil

There would be no impacts to surface water, groundwater, or soil from the cylinder overcontainer option for the entire cylinder inventory because no releases are associated with this option. The annual water requirement for a cylinder transfer facility would not change from that presented in Section 4.3.4.1 (i.e., about 7 million gal/yr), because the size of the facility would not change. However, the facility would be operated for an additional 6 years.

4.4.2.6 Socioeconomics

The annual socioeconomic impacts from cylinder preparation activities would be the same as those for the DOE-generated cylinders only estimated in Section 4.3.5, but the period of operation would be extended by 6 years. Construction impacts would not change for the cylinder preparation options because facility sizes would remain the same.

4.4.2.7 Ecology

Impacts to ecological resources from the preparation of the entire cylinder inventory (USEC- and DOE-generated) for shipment would be minimal, as discussed in Section 4.3.6. Concentrations of uranium in soil, groundwater, and surface water would remain well below benchmark values for toxic and radiological effects. (Benchmarks are given in Section C.3.3 of the PEIS.) In addition, construction activities for a cylinder transfer facility would likely take place in previously disturbed areas and thus would have minimal ecological impacts.

4.4.2.8 Waste Management

The annual volume of LLW waste generation from use of cylinder overcontainers or standard cylinder preparation would remain at 7.0 m^3/yr (Table 4.10); the total amount would increase from about 140 to 180 m^3. The impact of this increase on site or national radioactive waste management capabilities would be negligible.

The annual levels of LLW, LLMW, hazardous waste, and nonhazardous waste generated from construction and operation of a cylinder transfer facility would not change with consideration of the additional USEC cylinders, but operations would continue for 6 additional years. Impacts to Portsmouth site waste management capabilities would remain minimal, as discussed in Section 4.3.7. The maximum total volume of crushed, empty UF_6 cylinders generated at the Portsmouth site over

26 years would increase to about 46,000 m^3, representing a negligible to low impact (about a 2% addition) to the total projected DOE complexwide disposal volume.

4.4.2.9 Resource Requirements

In general, the addition of the USEC cylinders would not change the resource requirements for cylinder preparation. Cylinder overcontainers would be reused, so the total number required would remain about 175. The construction and operation requirements identified in Section 4.3.8 would remain the same, but operations would continue for an additional 6 years. Impacts to local and national supplies of resources would be minor.

4.4.2.10 Land Use

If a transfer facility were built for cylinder preparation, the land use requirements would be the same as those for the DOE-generated cylinders only described in Section 4.3.9, because the facility operational period would increase, not the facility size.

4.4.2.11 Cultural Resources

No impacts to cultural resources would be expected at the Portsmouth site from the cylinder overcontainer option. Impacts from a cylinder transfer facility cannot be determined at this time and would depend on the exact location within the site and whether eligible cultural resources existed on or near that location.

4.4.2.12 Environmental Justice

No disproportionately high and adverse effects to minority or low-income populations would be expected in the vicinity of the Portsmouth site in association with the cylinder preparation for the entire cylinder inventory (DOE- and USEC-generated cylinders).

5 ENVIRONMENTAL IMPACTS OF OPTIONS FOR CONVERSION OF UF_6 TO OXIDE OR METAL AT THE PORTSMOUTH SITE

Conversion of depleted UF_6 to another chemical form would be required for most alternative management strategies analyzed in the PEIS. Three different conversion options were considered in the PEIS: (1) conversion to triuranium octaoxide (U_3O_8), (2) conversion to uranium dioxide (UO_2), and (3) conversion to uranium metal. The specific conversion option considered under each of the alternatives is shown in Table 5.1. Because of their high chemical stability and low solubility, uranium oxides (i.e., U_3O_8 and UO_2) are considered for the storage and disposal alternatives. High-density UO_2 and uranium metal are considered for the use alternatives (e.g., spent nuclear fuel radiation shielding applications). Other details concerning the characteristics of the different chemical forms of uranium are given in Appendix A of the PEIS.

Conversion Options

Conversion of depleted UF_6 to another chemical form is required for a number of storage, use, and disposal management alternatives. The principal conversion options considered are as follows:

Conversion to U_3O_8. This chemical form is a stable, low-solubility oxide considered for storage and disposal. Two different technologies were considered for conversion to U_3O_8.

Conversion to UO_2. This stable, low-solubility oxide is considered for storage, disposal, and potential use as shielding material. Three different technologies were considered for conversion to UO_2.

Conversion to Metal. Metallic depleted uranium is considered for use as shielding material. Two different technologies were considered for conversion to metal.

Conversion of depleted UF_6 to another chemical form would take place at a stand-alone industrial plant dedicated to the conversion process. A representative conversion plant layout is shown in Figure 5.1; the actual plant layout would depend on the specific conversion option and technology selected, as well as on certain site characteristics. In general, the plant would be capable of receiving depleted UF_6 cylinders on trucks or railcars, temporarily storing a small inventory of full cylinders, processing the depleted UF_6 to another chemical form, and storing the converted uranium product and any other products until shipment off-site. The empty cylinders would be stored until transfer to a cylinder treatment facility, which is assumed to be located at the conversion plant site. It is estimated that a typical conversion plant would cover an area of approximately 20 acres (8 ha) (LLNL 1997).

In general, potential environmental impacts would occur during (1) construction of a conversion facility, (2) operations of the facility, and (3) postulated accidents. The potential impacts associated with facility construction would result from typical land-clearing and construction activities. Potential impacts during operations would occur primarily to workers during handling operations and to the public as a result of routine releases of small amounts of contaminants through

TABLE 5.1 Summary of the Conversion Options Considered for Each Programmatic Management Alternative

	Option Considered for Management Alternative[a]					
		Long-Term Storage		Use		
Option	No Action	UF_6	Oxide	Uranium Oxide	Uranium Metal	Disposal
Conversion to U_3O_8	–	–	X	–	–	X
Conversion to UO_2	–	–	X	X	–	X
Conversion to metal	–	–	–	–	X	–

[a] X = option considered; – = option not considered.

exhaust stacks and treated liquid effluent discharges. In addition, potential impacts to workers and the public from processing or storage might occur as a result of accidents that release hazardous materials.

The environmental impacts from the conversion options were evaluated based on the information described in the engineering analysis report (LLNL 1997). For each of the three conversion options (conversion to U_3O_8, UO_2, or metal), the engineering analysis report provides preconceptual facility design data, including descriptions of facility layouts; resource requirements; estimates of effluents, wastes, and emissions; and estimates of potential accident scenarios. Within each conversion option, several technologies or chemical processes that could be used to produce the same uranium end product are described (two are considered for conversion to U_3O_8, three for conversion to UO_2, and two for conversion to metal). Some of these technologies have not been demonstrated on a commercial scale but were considered to provide an estimate of the range of the environmental impacts that might be associated with each of the conversion options. All facility designs were based on a single plant sized to process the entire inventory of DOE-generated depleted UF_6 cylinders over a 20-year period (approximately 2,300 cylinders per year).

In the PEIS, the analyses of the conversion options assumed that the three current storage sites were representative of sites that might actually be used for these activities. Analyses were conducted by using site-specific data for each of the three current storage sites (Paducah, Portsmouth, and K-25). After the analyses were completed, the results were aggregated and presented as a range that accounted for differences in the sites as well as differences in technologies that might be used in the future. In this report, ranges of impacts from the different conversion technologies examined in the PEIS are presented specifically for the Portsmouth site. Although the analyses for conversion used some data on the Portsmouth site, these analyses are not sufficient to

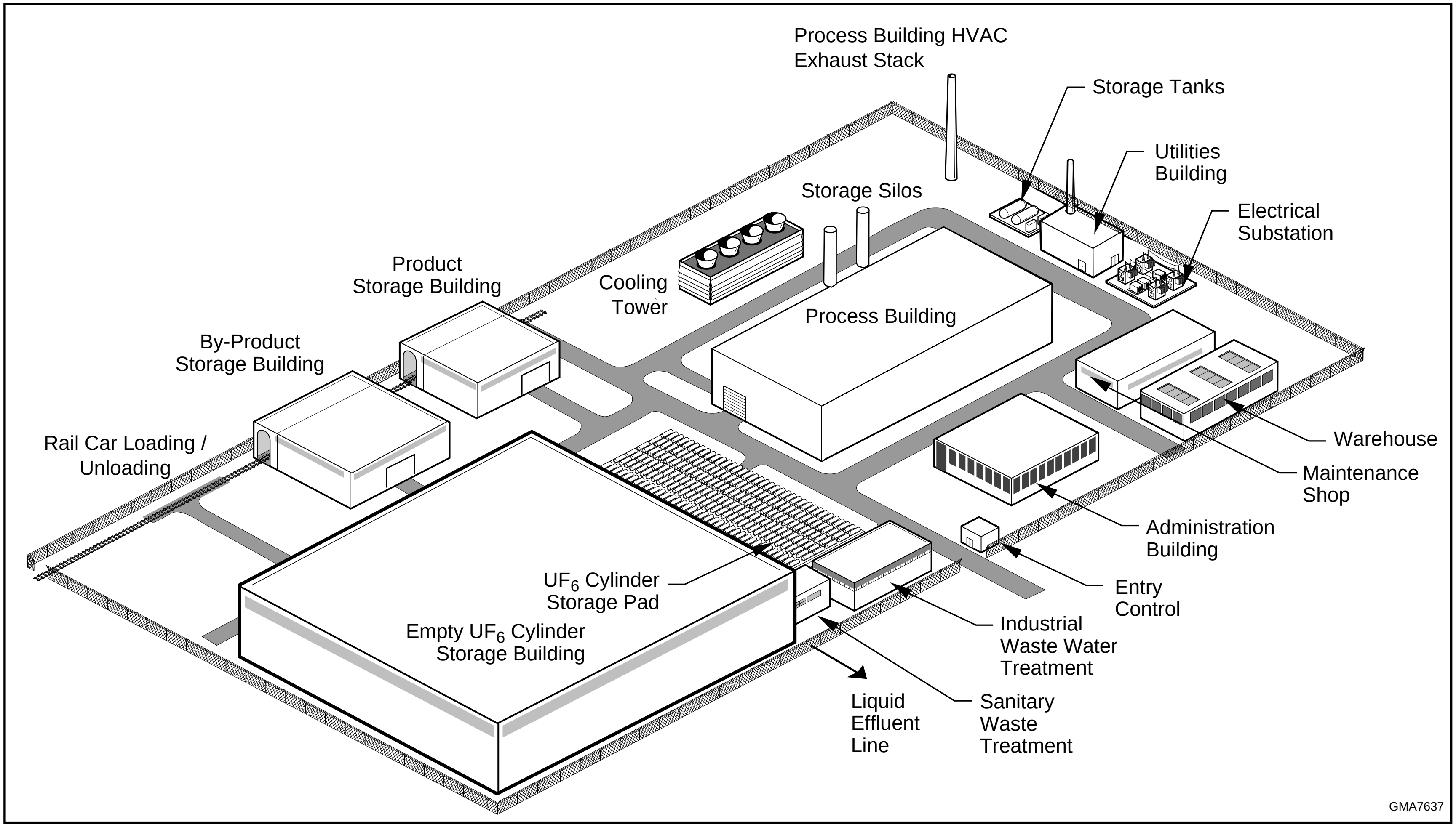

FIGURE 5.1 Representative Site Layout for a Conversion Facility

completely fulfill NEPA requirements for site-specific environmental analyses for an actual conversion facility. For such analyses, detailed technology design and effluent data must be available, as well as data on exactly where within the Portsmouth site the facilities would be located.

5.1 SUMMARY OF CONVERSION OPTION IMPACTS

The potential environmental impacts for the three conversion options, with the Portsmouth site used as a representative location, are compared in Table 5.2. For each conversion option, the potential environmental impacts are presented as a range within each area of impact. This range is intended to provide a reasonable estimate of the magnitude of impacts, taking into account the uncertainty relative to the specific technologies that could ultimately be selected for conversion. The range of impacts results from fundamental differences among the technologies within each conversion option. A more detailed assessment of specific technologies and site conditions will be conducted, as appropriate, as part of the second phase (tier) of the programmatic NEPA approach. Additional discussion and details related to the assessment methodologies and results for individual areas of impact are provided in the remainder of this section

After the draft PEIS was completed, management responsibility for approximately 11,200 additional cylinders of depleted UF_6 was transferred from USEC to DOE. To provide a bounding analysis of environmental impacts, the final PEIS evaluated the environmental impacts of managing an additional 15,000 cylinders. The impacts associated with conversion of the total inventory (including USEC-generated cylinders) at the Portsmouth site are summarized in Section 5.4 of this document. A summary of the estimated environmental impacts associated with conversion of the DOE-generated cylinders only and the total cylinder inventory (DOE-generated plus USEC-generated) is presented in Table 5.2.

5.2 DESCRIPTION OF OPTIONS

This section provides a brief summary of the different conversion options considered in the assessment of conversion impacts (Table 5.3). The information is based on preconceptual design data provided in the engineering analysis report (LLNL 1997). The engineering analysis report includes much more detailed information, such as descriptions of facility layouts; resource requirements; estimates of effluents, wastes, and emissions; and estimates of potential accident scenarios.

All of the conversion options would involve the removal of depleted UF_6 from the storage cylinders, resulting in a large number of empty cylinders. These empty cylinders would contain approximately 22 lb (10 kg) of depleted UF_6 (Charles et al. 1991), called “heels.” For assessment purposes, it has been assumed that a cylinder treatment facility would be constructed to wash the empty cylinders. This facility has been assumed to be an independent, or “stand-alone,” facility, although it could be integrated directly into the design of the conversion plant. The facility would be co-located with the conversion plant.

TABLE 5.2 Summary of Conversion Option Impacts for the Portsmouth Site[a]

Impacts from Conversion to U_3O_8	Impacts from Conversion to UO_2	Impacts from Conversion to Metal	Impacts from Cylinder Treatment[b]
Human Health – Normal Operations: Radiological			
Involved Workers: Total collective dose: 820 person-rem [1,100 person-rem]	**Involved Workers:** Total collective dose: 980 – 1,100 person-rem [1,300 – 1,400 person-rem]	**Involved Workers:** Total collective dose: 650 – 1,300 person-rem [850 – 1,700 person-rem]	**Involved Workers:** Total collective dose: 320 person-rem [420 person-rem]
Total number of LCFs: 0.3 LCF [0.4 LCF]	Total number of LCFs: 0.4 LCF [0.5 – 0.6 LCF]	Total number of LCFs: 0.3 – 0.5 LCF [0.3 – 0.7 LCF]	Total number of LCFs: 0.1 LCF [0.2 LCF]
Noninvolved Workers: Annual dose to MEI: 4.9×10^{-3} mrem/yr	**Noninvolved Workers:** Annual dose to MEI: $9.7 \times 10^{-3} – 1.9 \times 10^{-2}$ mrem/yr	**Noninvolved Workers:** Annual dose to MEI: $2.1 \times 10^{-3} – 1.5 \times 10^{-2}$ mrem/yr	**Noninvolved Workers:** Annual dose to MEI: 1.5×10^{-5} mrem/yr
Annual cancer risk to MEI: 2×10^{-9} per year	Annual cancer risk to MEI: $4 \times 10^{-9} – 7 \times 10^{-9}$ per year	Annual cancer risk to MEI: $8 \times 10^{-8} – 6 \times 10^{-9}$ per year	Annual cancer risk to MEI: 6×10^{-12} per year
Total collective dose: 0.07 person-rem [0.09 person-rem]	Total collective dose: 0.014 – 0.26 person-rem [0.018 – 0.34 person rem]	Total collective dose: 0.03 – 0.2 person-rem [0.04 – 0.26 person-rem]	Total collective dose: 2.0×10^{-4} person-rem [3×10^{-4} person-rem]
Total number of LCFs: 3×10^{-5} LCF [4×10^{-5} LCF]	Total number of LCFs: $6 \times 10^{-6} – 1 \times 10^{-4}$ LCF [$7 \times 10^{-6} – 1 \times 10^{-4}$ LCF]	Total number of LCFs: $1 \times 10^{-5} – 8 \times 10^{-5}$ LCF [$2 \times 10^{-5} – 1 \times 10^{-4}$ LCF]	Total number of LCFs: 8×10^{-8} LCF [1×10^{-7} LCF]
General Public: Annual dose to MEI: 8.8×10^{-3} mrem/yr	**General Public:** Annual dose to MEI: $1.7 \times 10^{-2} – 3.3 \times 10^{-2}$ mrem/yr	**General Public:** Annual dose to MEI: $3.7 \times 10^{-3} – 2.6 \times 10^{-2}$ mrem/yr	**General Public:** Annual dose to MEI: 2.7×10^{-5} mrem/yr
Annual cancer risk to MEI: 4×10^{-9} per year	Annual cancer risk to MEI: $9 \times 10^{-9} – 2 \times 10^{-8}$ per year	Annual cancer risk to MEI: $2 \times 10^{-9} – 1 \times 10^{-8}$ per year	Annual cancer risk to MEI: 1×10^{-11} per year
Total collective dose to population within 50 miles: 0.79 person-rem [1 person-rem]	Total collective dose to population within 50 miles: 1.6 – 3 person-rem [2.1 – 3.9 person-rem]	Total collective dose to population within 50 miles: 0.74 – 5.2 person-rem [0.96 – 6.8 person-rem]	Total collective dose to population within 50 miles: 0.0024 person-rem [0.0031 person-rem]
Total number of LCFs in population within 50 miles: 0.0004 LCF [0.0005 LCF]	Total number of LCFs in population within 50 miles: 0.0008 – 0.001 LCF [0.001 – 0.002 LCF]	Total number of LCFs in population within 50 miles: 0.0004 – 0.003 LCF [0.0005 – 0.003 LCF]	Total number of LCFs in population within 50 miles: 1×10^{-6} LCF [2×10^{-6} LCF]

TABLE 5.2 (Cont.)

Impacts from Conversion to U_3O_8	Impacts from Conversion to UO_2	Impacts from Conversion to Metal	Impacts from Cylinder Treatment[b]
Human Health – Normal Operations: Chemical			
Noninvolved Workers: No impacts	**Noninvolved Workers:** No impacts	**Noninvolved Workers:** No impacts	**Noninvolved Workers:** No impacts
General Public: No impacts	**General Public:** No impacts	**General Public:** No impacts	**General Public:** No impacts
Human Health – Accidents: Radiological			
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence): Dose to MEI: 9.2 rem Risk of LCF to MEI: 4×10^{-3} Collective dose: 840 person-rem Number of LCFs: 0.3	**Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 2.3 rem Risk of LCF to MEI: 9×10^{-4} Collective dose: 210 person-rem Number of LCFs: 0.08	**Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 0.02 rem Risk of LCF to MEI: 8×10^{-6} Collective dose: 4.5 person-rem Number of LCFs: 2×10^{-3}	**Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 0.43 rem Risk of LCF to MEI: 2×10^{-4} Collective dose: 38 person-rem Number of LCFs: 0.02
General Public: Bounding accident consequences (per occurrence): Dose to MEI: 0.26 rem Risk of LCF to MEI: 1×10^{-4} Collective dose to population within 50 miles: 9.8 person-rem Number of LCFs in population within 50 miles: 0.005 LCF	**General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.064 rem Risk of LCF to MEI: 3×10^{-5} Collective dose to population within 50 miles: 2.4 person-rem Number of LCFs in population within 50 miles: 0.001 LCF	**General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.013 rem Risk of LCF to MEI: 6×10^{-6} Collective dose to population within 50 miles: 27 person-rem Number of LCFs in population within 50 miles: 0.01 LCF	**General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.012 rem Risk of LCF to MEI: 6×10^{-6} Collective dose to population within 50 miles: 1.2 person-rem Number of LCFs in population within 50 miles: 0.0006 LCF

TABLE 5.2 (Cont.)

Impacts from Conversion to U_3O_8	Impacts from Conversion to UO_2	Impacts from Conversion to Metal	Impacts from Cylinder Treatment[b]
Human Health – Accidents: Chemical			
Bounding accident frequency: less than once in 1 million years	Bounding accident frequency: less than once in 1 million years	Bounding accident frequency: less than once in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 740 persons	Number of persons with potential for adverse effects: 740 persons	Number of persons with potential for adverse effects: 740 persons	Number of persons with potential for adverse effects: 1 person
Number of persons with potential for irreversible adverse effects: 460 persons	Number of persons with potential for irreversible adverse effects: 460 persons	Number of persons with potential for irreversible adverse effects: 460 persons	Number of persons with potential for irreversible adverse effects: 0 persons
General Public: Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 18,000 persons	Number of persons with potential for adverse effects: 18,000 persons	Number of persons with potential for adverse effects: 18,000 persons	Number of persons with potential for adverse effects: 0 persons
Number of persons with potential for irreversible adverse effects: 1,200 persons	Number of persons with potential for irreversible adverse effects: 1,200 persons	Number of persons with potential for irreversible adverse effects: 1,200 persons	Number of persons with potential for irreversible adverse effects: 0 persons
Human Health — Accidents: Physical Hazards			
Construction and Operations: **All Workers:** 0.35 [0.46] fatality, approximately 290 [380] injuries	**Construction and Operations:** **All Workers:** 0.59 [0.78] fatality, approximately 490 [650] injuries	**Construction and Operations:** **All Workers:** 0.55 [0.73] fatality, approximately 490 [650] injuries	**Construction and Operations:** **All Workers:** 0.19 [0.25] fatality, approximately 170 [220] injuries

TABLE 5.2 (Cont.)

Impacts from Conversion to U_3O_8	Impacts from Conversion to UO_2	Impacts from Conversion to Metal	Impacts from Cylinder Treatment[b]
Air Quality			
Construction: 24-hour PM_{10} concentration potentially as large as 50% of standard. Concentrations of other criteria pollutants all below 15% of respective standards.	**Construction:** 24-hour PM_{10} concentration potentially as large as 50% of standard. Concentrations of other criteria pollutants all below 30% of respective standards.	**Construction:** 24-hour PM_{10} concentration potentially as large as 50% of standard. Concentrations of other criteria pollutants all below 20% of respective standards.	**Construction:** 24-hour PM_{10} concentration potentially as large as 17% of standard. Concentrations of other criteria pollutants all below 10% of respective standards.
Operations: 8-hour CO concentration potentially as large as 1% of standard.	**Operations:** 8-hour CO concentration potentially as large as 2% of standard.	**Operations:** 8-hour CO concentration potentially as large as 2% of standard.	**Operations:** Concentrations of all criteria pollutants below 0.1% of respective standards.
Water			
Construction: None to negligible physical impacts; concentrations less than applicable standards	**Construction:** None to negligible physical impacts; concentrations less than applicable standards	**Construction:** None to negligible physical impacts; concentrations less than applicable standards	**Construction:** None to negligible physical impacts; concentrations less than applicable standards
Operations: None to negligible physical impacts to surface water and groundwater; concentrations less than applicable standards	**Operations:** None to negligible physical impacts to surface water and groundwater; concentrations less than applicable standards	**Operations:** None to negligible physical impacts to surface water and groundwater; concentrations less than applicable standards	**Operations:** None to negligible physical impacts to surface water and groundwater; concentrations less than applicable standards
Soil			
Construction: None to negligible impacts	**Construction:** None to negligible impacts	**Construction:** None to negligible impacts	**Construction:** None to negligible impacts
Operations: None to negligible physical impacts; concentrations less than applicable guidelines	**Operations:** None to negligible physical impacts; concentrations less than applicable guidelines	**Operations:** None to negligible physical impacts; concentrations less than applicable guidelines	**Operations:** None to negligible physical impacts; concentrations less than applicable guidelines

TABLE 5.2 (Cont.)

Impacts from Conversion to U_3O_8	Impacts from Conversion to UO_2	Impacts from Conversion to Metal	Impacts from Cylinder Treatment[b]
***Socioeconomics*[c]**			
Jobs: 240-250 peak year, construction, 200-210/year over 20 years, operations [over 26 years, operations]	**Jobs:** 330-630 peak year, construction, 230-360/year over 20 years, operations [over 26 years, operations]	**Jobs:** 380-440 peak year, construction, 210-370/year over 20 years, operations [over 26 years, operations]	**Jobs:** 100 peak year, construction, 130/year over 20 years, operations [over 26 years, operations]
Income: $11 million peak year, construction, $10 million/year over 20 years, operations [over 26 years, operations]	**Income:** $15-28 million peak year, construction, $11-18 million/year over 20 years, operations [over 26 years, operations]	**Income:** $12-16 million peak year, construction, $10-18 million/year over 20 years operations [over 26 years operations]	**Income:** $5 million peak year, construction; $10 million/year over 20 years, operations [over 26 years, operations]
Construction and Operations: Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances	**Construction and Operations:** Negligible to low impacts to ROI employment and population growth rates and to public finances; potential moderate impacts to vacant housing	**Construction and Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances.	**Construction and Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances.
Ecology			
Construction: Potential moderate impacts to vegetation and wildlife	**Construction:** Potential moderate impacts to vegetation and wildlife	**Construction:** Potential moderate impacts to vegetation and wildlife	**Construction:** Potential moderate impacts to vegetation and wildlife
Operations: Negligible impacts	**Operations:** Negligible impacts	**Operations:** Negligible impacts	**Operations:** Negligible impacts
Waste Management			
Potential moderate impacts to site, regional, or national waste management operations	Potential moderate impacts to site, regional, or national waste management operations	Potential moderate impacts to site, regional, or national waste management operations	Potential moderate impacts to national waste management operations

TABLE 5.2 (Cont.)

Impacts from Conversion to U_3O_8	Impacts from Conversion to UO_2	Impacts from Conversion to Metal	Impacts from Cylinder Treatment[b]
	Resource Requirements		
No impacts from resource requirements (such as electricity or materials) on the local or national scale	No impacts from resource requirements (such as electricity or materials) on the local or national scale	No impacts from resource requirements (such as electricity or materials) on the local or national scale	No impacts from resource requirements (such as electricity or materials) on the local or national scale
	Land Use[d]		
Construction: Use of approximately 20 acres; negligible impacts	**Construction:** Use of approximately 22 to 31 acres; negligible impacts	**Construction:** Use of approximately 23 to 26 acres; negligible impacts	**Construction:** Use of approximately 9 acres; negligible impacts
Operations: Use of approximately 13 acres; negligible impacts	**Operations:** Use of approximately 14 to 20 acres; negligible impacts	**Operations:** Use of approximately 15 to 16 acres; negligible impacts	**Operations:** Use of approximately 5 acres; negligible impacts

[a] In general, the overall environmental consequences from managing the total cylinder inventory (total of USEC-generated and DOE-generated cylinders) are the same as those from managing the DOE-generated cylinders only. In this table, when the consequences for the total inventory differ from those for the DOE-generated cylinders only, the consequences for the total inventory are presented in brackets following the consequences for DOE cylinders only. CO = carbon monoxide, LCF = latent cancer fatality, MEI = maximally exposed individual, PM_{10} = particulate matter with a mean diameter of 10 µm or less, ROI = region of influence.

[b] These impacts must be added to those for each of the conversion options.

[c] For construction, direct jobs and income are reported for the peak construction year. For operations, direct jobs and income are presented as annual averages. See Section 5.3.5 for details are indirect impacts in the Portsmouth site ROI.

[d] Land-use acreages given as maximum for a single site or facility. Conversion facilities would also need to establish protective action distances encompassing about 960 acres around the facility.

TABLE 5.3 Summary of Technologies Considered under Each Conversion Option

Conversion Option	Technologies
Conversion to U_3O_8	- Defluorination with anhydrous HF production - Defluorination with HF neutralization
Conversion to UO_2	- Dry process with anhydrous HF production - Dry process with HF neutralization - Gelation process
Conversion to metal	- Batch metallothermic reduction - Continuous metallothermic reduction

Following removal of the depleted UF_6, the emptied cylinders containing "heels" would be stored for about 3 months to allow the level of radioactivity associated with the decay products of uranium that remained after UF_6 withdrawal to decrease to acceptable levels. Subsequently, in the proposed cylinder treatment facility, the emptied cylinders are first washed with water and the resulting aqueous wash solution is evaporated and converted to solid U_3O_8 and HF. The U_3O_8 would be packaged and sent either for disposal or storage. The HF would be neutralized to calcium fluoride (CaF_2) and separately packaged for disposal or sale.

It was assumed that the treated cylinders with a very low residual radiation level would become part of the DOE scrap metal inventory. A report by Nieves et al. (1997) analyzed the potential health and cost impacts associated with various options for the empty cylinders after treatment, including recycle into LLW disposal containers, reuse as LLW containers, free release for remelting, and disposal (i.e., burial) as LLW. Health endpoints assessed included chemical risks, radiation risks, and trauma risks. The estimated total health risks over 20 years of processing ranged from 0.1 to 0.8 total fatality for the various options. The potential health impacts were similar for each of the options; however, the disposal option was considered to have the greatest adverse environmental impacts because it would require land allocations and removal of the metal mass from any further usefulness.

5.2.1 Conversion to U_3O_8

A "dry" process, referred to as defluorination, is well established and currently used by industry. It is also practiced on a large-scale industrial basis by Cogema in France. In this process, UF_6 is chemically decomposed with steam and heat to produce U_3O_8 and concentrated HF. The U_3O_8 would then be compacted to achieve a bulk density of about 3 g/cm^3 prior to storage or disposal.

Two technologies were considered for management of the HF following conversion of UF_6 to U_3O_8. The first process would upgrade the concentrated HF to anhydrous HF for sale. Anhydrous HF is a valuable product; one potential use for HF is in the production of UF_6 from natural uranium ore for feedstock to the gaseous diffusion process. The second process would neutralize the HF to CaF_2 for disposal or sale, depending on whether the CaF_2 with trace amounts of uranium could be marketed.

Because of the considerable market for anhydrous HF, the technology of defluorination with anhydrous HF production would minimize waste and increase product value. However, the handling, storage, and transportation of large quantities of anhydrous HF pose a potential hazard to both workers and the public. During the conversion process, the HF would be upgraded to anhydrous HF by distillation, a common industrial process. Based on historical experience, it is anticipated that the anhydrous HF would contain only trace amounts of depleted uranium (less than 1 ppm, or 0.4 pCi/g) (LLNL 1997). Thus, it was assumed that the anhydrous HF could be sold commercially for unrestricted use.

The process of HF neutralization with lime would convert the concentrated HF to CaF_2 for disposal or possible sale. This step would avoid the potential hazards associated with the processing, general handling, storage, and transportation of large quantities of anhydrous HF. However, the value of CaF_2 is significantly less than that of anhydrous HF, and large quantities of lime are required for neutralization, which would add to the cost of the neutralization option. It is also unknown whether the CaF_2 produced would be sold, disposed of as nonhazardous solid waste, or disposed of as LLW. If disposal were required, there could be moderate impacts to waste management (see Section 5.3.7).

5.2.2 Conversion to UO_2

The conversion of UF_6 to UO_2 is used in the nuclear fuel fabrication industry. The UF_6 is converted to a low-density UO_2 powder by either a “wet” or “dry” process. “Wet” processes are based upon separation of solid UO_2 from an aqueous solution, whereas “dry” processes are based upon decomposing and reducing the UF_6. The resulting powder is pressed into a pellet under high pressure, and the pellet is sintered (agglomerated) at high temperatures to yield a dense solid. Depending on the shape, size, and size distribution, the bulk density of UO_2 will generally be 6 to 9 g/cm^3.

Three technologies were considered for the conversion of UF_6 to UO_2. A generic industrial dry process with conversion to produce centimeter-sized pellets is the basis for the first two technologies. The first process would upgrade the concentrated HF to anhydrous HF for sale, similar to the U_3O_8 process. The second process would neutralize the HF to CaF_2 for disposal or sale. The third process is a “wet” process, based on pilot-scale studies, and is referred to as the gelation process.

In the dry process, gaseous UF_6 would be chemically reacted with steam to produce solid UO_2F_2 and HF. The UO_2F_2 would then be converted to UO_2 powder through a combination of chemical reactions. Using standard physical treatment operations (milling, compacting, and screening) and the addition of a dry lubricant, the UO_2 powder would be pressed into dense pellets with a bulk density of about 6 g/cm^3. The HF would be upgraded to anhydrous HF for commercial resale, as described in Section 5.2.1. In the other dry process, the HF would be neutralized to CaF_2 rather than upgraded to anhydrous HF.

In the gelation process, small, dense spheres of UO_2 would be produced through a combination of chemical processes beginning with the conversion of UF_6 to UO_2F_2 and anhydrous HF. The solid UO_2F_2 would then be reacted with steam to produce U_3O_8 and additional anhydrous HF. The U_3O_8 would be dissolved in nitric acid, mixed with other chemicals, and chilled to form a feed broth. This broth would be formed into droplets and fed into a column of hot chlorinated hydrocarbon liquid. Once these droplets formed into spheres, they would be removed from the hot liquid and washed. The droplets would then be dried and converted by heating to dense uranium oxide. The final sintered uranium dioxide spheres are expected to have a density of about 95% or greater of the theoretical maximum density of uranium dioxide, resulting in a bulk density of about 9 g/cm^3. The gelation process has not been demonstrated on a commercial scale.

5.2.3 Conversion to Metal

The conversion of UF_6 to uranium metal would use a commercial process called metallothermic reduction. During this process, UF_6 would react with both hydrogen and magnesium metal to produce uranium metal, anhydrous HF, and magnesium fluoride ($MgFl_2$; slag). Two technologies were considered: a batch reduction process, which is the method used to date, and a continuous reduction process, which is under development and has not been demonstrated on a commercial scale.

In the batch metallothermic reduction process, the UF_6 would be mixed with hydrogen gas in a vertical reaction vessel to form UF_4 and HF. The anhydrous HF would be recovered and stored for sale. The UF_4 powder and an excess of magnesium would be contained in a sealed metal vessel and preheated. Once initiated, the reaction would produce molten uranium metal (collecting at the bottom of the reactor) and less dense molten MgF_2 slag. The cycle time per batch (about 12 hours total) would be dominated by the heating and cooling periods. A large number of reactors would be required because of the long cycle time. The slag would be ground, screened, and prepared for disposal. Any metal pellets would be recovered for recycle.

In the continuous metallothermic reduction process, the UF_6 would be mixed with hydrogen gas in a vertical reaction vessel to form UF_4 and HF. The anhydrous HF would be recovered and stored for sale. A mixture of UF_4, magnesium (Mg), iron (Fe), and salt would be continuously fed into the top of a heated reactor. The more dense molten uranium/iron compound would settle to the bottom of the reactor where it would be continuously withdrawn. The lower-density MgF_2/salt mixture would float on top and be separately withdrawn. The molten uranium/iron compound would then be cast into ingots or the end-product form if the manufacturing function was integrated into the conversion facility. The molten salt mixture would be cooled and ground and the water-soluble salt dissolved. After evaporation and drying, the salt would be recycled to the reactor. The insoluble MgF_2 would be drummed for disposal. The annual throughput of the continuous metallothermic reduction reactor would be greater than a batch reactor, requiring fewer reactors.

Neutralization of HF to CaF_2 was not explicitly analyzed in the engineering analysis report for the conversion to metal options (LLNL 1997). However, the process could be implemented and would produce approximately one-third as much CaF_2 as would be produced under the conversion to oxide with neutralization options.

5.2.4 Conversion Technologies and Chemical Forms Considered But Not Analyzed in Detail

The conversion technologies analyzed in the engineering analysis report (LLNL 1997) and the PEIS are those with a sufficient technical basis to carry out preconceptual designs. A number of other promising conversion technologies were considered, but, with minor exceptions, these are in the early stages of conceptualization or development. These options are also discussed in the engineering analysis report (LLNL 1997).

For conversion to an oxide form, technologies considered but not analyzed in detail include a molten metal catalyzed process; the Cameco process (patent pending), which uses a different chemical process than steam hydrolysis/pyrolysis; a conversion process that produces a by-product of aluminum trifluoride (AlF_3); and a defluorination process that results in the production of hydrofluorocarbons. For conversion to metal, a plasma dissociation process was considered but not analyzed in detail.

5.3 IMPACTS OF OPTIONS

This section provides a summary of the potential environmental impacts associated with the conversion options, including impacts from construction and facility operations. For each area of impact, a description of the assessment methodology (including models) is provided in Appendix C of the PEIS.

The environmental impacts from the conversion options were evaluated based on the information described in the engineering analysis report (LLNL 1997). The following general assumptions apply to all conversion facility operations:

- All facility designs were based on a single conversion plant sized to process the entire inventory of DOE-generated depleted UF_6 cylinders over a 20-year period (approximately 2,300 cylinders per year). (When USEC-generated cylinders are considered, operations are assumed to continue for an additional 6 years; see Section 5.4.)

- The conversion plant was assumed to operate 24 hours per day, 7 days per week, 52 weeks per year, with 20% down-time.

- A "stand-alone" cylinder treatment facility (for empty cylinders) is collocated with the conversion plant.

For each conversion option, the potential environmental impacts are presented as a range within each area of impact. This range is intended to provide a reasonable estimate of the magnitude of impacts, taking into account the uncertainty relative to the specific technologies that would ultimately be selected for conversion.

5.3.1 Human Health — Normal Operations

5.3.1.1 Radiological Impacts

Radiological impacts to involved workers during normal operations at conversion facilities would result primarily from external radiation from the handling of depleted uranium materials. Impacts to noninvolved workers and members of the public would result primarily from trace amounts of uranium compounds released to the environment. Detailed discussions of the methodologies used in radiological impact analysis are provided in Appendix C of the PEIS and in Cheng et al. (1997).

Radiation exposures of the involved workers were estimated by using the anticipated worker activities provided in the engineering analysis report (LLNL 1997). These worker activities included activities conducted by involved workers and noninvolved workers combined. Therefore, special attention was given to estimating the number of involved workers, defined as those performing hands-on activities in the conversion facility. Because the exact activities of each involved worker were not clear at this stage, estimating the individual dose for each worker was difficult. As a result, only the collective dose and average individual dose were calculated for involved workers. Spreadsheets listing the worker activities and the corresponding dose rates can be found on disk 3 of Cheng et al. (1997) under the file name conv-tm.xls.

Noninvolved workers include workers who would not perform hands-on activities in the conversion facility and those who currently work at the Portsmouth site. Because distribution of the noninvolved workers in the conversion facility was not known at this time, an even distribution between 100 and 200 m around the center of the site, where the conversion facility was assumed to be constructed, was assumed. Workers that currently work at the Portsmouth site within 100 m from the center were assumed to be relocated to the outer annulus of 100 to 200 m. Locations of the remaining workers at the Portsmouth site were assumed to be unchanged. The on-site worker distribution before addition of the noninvolved workers from the conversion facility can be found on disk 1 of Cheng et al. (1997) under the file name pop-wrk.xls.

To estimate airborne concentrations of uranium at different locations, radionuclide emission data from the exhaust stack (LLNL 1997), along with the site-specific weather data (wind direction and joint frequency), were used. This information was input to the GENII computer code to obtain air concentrations of uranium at different locations and to find the location of the MEI. The weather data used in the analyses can be found on disk 1 of Cheng et al. (1997) under the file name weather.xls.

Collective exposure of the off-site public was also estimated by considering airborne emissions of uranium from the exhaust stack. Distributions of the off-site population used in the estimate can be found on disk 1 of Cheng et al. (1997) under the file name Pop-off.xls. For the MEI, in addition to the exposure resulting from the stack emission, potential exposure resulting from discharge of liquid effluent was also considered. The discharge of liquid effluent could contaminate a nearby river, which was assumed to be the drinking water source for the MEI. Concentrations of uranium in the surface water were obtained from Tomasko (1997b), and the estimated range can be found on disk 1 of Cheng et al. (1997) under the file name Wtimpact.xls.

Estimated potential impacts to the MEI and the entire population for the noninvolved workers and the off-site public resulting from airborne emission of radionuclides can be found on disk 1 of Cheng et al. (1997) under the file name Airimpct.xls.

5.3.1.1.1 Conversion to U_3O_8

Conversion to U_3O_8 would result in average radiation exposure of about 300 mrem/yr to involved workers and less than 0.01 mrem/yr to noninvolved workers and members of the public. Radiation doses and cancer risks associated with normal operations of the U_3O_8 conversion facilities are listed in Tables 5.4 and 5.5, respectively. The two conversion technologies evaluated are described in Section 5.2.1. Due to the similarity of the conversion processes, the airborne emission rates of uranium compounds and the material handling activities are expected to vary only slightly from each other, resulting in similar radiological impacts.

TABLE 5.4 Radiological Doses from Conversion/Treatment Options under Normal Operations[a]

	Dose to Receptor					
	Involved Workers[b]		Noninvolved Workers[c]		General Public	
Option	Average Dose (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose[d] (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose[e] (mrem/yr)	Collective Dose[f] (person-rem/yr)
Conversion to U_3O_8	300	41	4.9×10^{-3}	3.4×10^{-3}	8.8×10^{-3}	3.9×10^{-2}
Conversion to UO_2	180 – 340	49 – 54	9.7×10^{-3} – 1.9×10^{-2}	6.8×10^{-3} – 1.3×10^{-2}	1.7×10^{-2} – 3.3×10^{-2}	7.8×10^{-2} – 1.5×10^{-1}
Conversion to metal	230 – 240	33 – 67	2.1×10^{-3} – 1.5×10^{-2}	1.5×10^{-3} – 1.0×10^{-2}	3.7×10^{-3} – 2.6×10^{-2}	1.7×10^{-2} – 1.2×10^{-1}
Cylinder treatment	160	16	1.5×10^{-5}	1.0×10^{-5}	2.7×10^{-5}	1.2×10^{-4}

[a] Impacts are reported as ranges, which result from the different conversion technologies within each option.

[b] Involved workers are those workers directly involved with the handling of radioactive materials. Calculation results are presented as average individual dose and collective dose for the worker population. Radiation doses to individual workers would be monitored by a dosimetry program and maintained below applicable standards, such as the DOE administrative control limit of 2,000 mrem/yr.

[c] Noninvolved workers include individuals who work at the facility but are not directly involved in handling materials and individuals who work on-site but not within the facility. The size of the population of noninvolved workers is about 2,600.

[d] The MEI for the noninvolved workers was assumed to be located on-site 100 m or more from the release point at the location that would result in the largest dose, which includes doses from inhalation, external radiation, and incidental soil ingestion.

[e] The MEI for the general public was assumed to be located off-site at the point that would result in the largest dose from exposures through inhalation, external radiation, and ingestion of plant foods, meat, milk, soil, and drinking water.

[f] Collective dose was estimated for the populations (approximately 630,000 persons) within a radius of 50 miles (80 km) around the Portsmouth site. The exposure pathways considered were inhalation, external radiation, and ingestion of plant foods, meat, milk, and soil.

TABLE 5.5 Latent Cancer Risks from Conversion/Treatment Options under Normal Operations[a]

	Latent Cancer Risk to Receptor					
	Involved Workers[b]		Noninvolved Workers[c]		General Public	
Option	Average Risk (risk/yr)	Collective Risk (fatalities/yr)	MEI Risk[d] (risk/yr)	Collective Risk (fatalities/yr)	MEI Risk[e] (risk/yr)	Collective Risk[f] (fatalities/yr)
Conversion to U_3O_8	1×10^{-4}	2×10^{-2}	2×10^{-9}	2×10^{-6}	4×10^{-9}	2×10^{-5}
Conversion to UO_2	7×10^{-5} – 1×10^{-4}	2×10^{-2}	4×10^{-9} – 7×10^{-9}	3×10^{-6} – 5×10^{-6}	9×10^{-9} – 2×10^{-8}	4×10^{-5} – 7×10^{-5}
Conversion to metal	9×10^{-5} – 1×10^{-4}	1×10^{-2} – 3×10^{-2}	8×10^{-8} – 6×10^{-9}	6×10^{-7} – 4×10^{-6}	2×10^{-9} – 1×10^{-8}	8×10^{-6} – 6×10^{-5}
Cylinder treatment	6×10^{-5}	6×10^{-3}	6×10^{-12}	4×10^{-9}	1×10^{-11}	6×10^{-8}

[a] Impacts are reported as ranges, which result from the different conversion technologies within each option.

[b] Involved workers are those workers directly involved with the handling of radioactive materials. Calculation results are presented as average individual risk and collective risk for the worker population.

[c] Noninvolved workers include individuals who work at the facility but are not directly involved in handling materials and individuals who work on-site but not within the facility. The size of the population of noninvolved workers is about 2,600.

[d] The MEI for the noninvolved workers was assumed to be located on-site 100 m or more from the release point that would result in the largest risk, which includes risks from inhalation, external radiation, and incidental soil ingestion.

[e] The MEI for the general public was assumed to be located off-site at the point that would result in the largest risk from exposures through inhalation, external radiation, and ingestion of plant foods, meat, milk, soil, and drinking water.

[f] Collective risk was estimated for the populations (approximately 630,000) within a radius of 50 miles (80 km) around the Portsmouth site. The exposure pathways considered were inhalation, external radiation, and ingestion of plant foods, meat, milk, and soil.

Involved Workers. Radiation exposures for the involved workers are estimated according to the descriptions of material handling activities provided in the engineering analysis report (LLNL 1997). Due to the preliminary nature of each facility design, the estimated radiation doses are subject to a large degree of uncertainty. The results presented in this appendix should be used only for purposes of comparison among different technologies. Radiation exposure of involved workers would be monitored by a dosimetry program and maintained below regulatory limits.

The collective dose for involved workers is estimated to be about 41 person-rem/yr for 135 workers for the U_3O_8 conversion processes. This would result in about 0.02 excess LCF per year (or about 2 LCFs over a 100-year period) among the involved workers. If evenly distributed among involved workers, the average individual dose would be approximately 300 mrem/yr, well below the regulatory limit of 5,000 mrem/yr for workers (10 CFR Part 835). This corresponds to an average cancer risk of about 1×10^{-4} per year (1 chance in 10,000 of developing 1 LCF per year).

Noninvolved Workers. Estimated doses and health risks are much lower for noninvolved workers than for involved workers. Inhalation of U_3O_8 particulates accounts for more than 99.9% of the radiological exposures for noninvolved workers. The radiation dose (risk of an LCF) to a maximally exposed noninvolved worker would be approximately 4.9×10^{-3} mrem/yr (2×10^{-9} per year), which is a very small fraction (less than 1 in 2,000) of the maximally allowable dose limit (10 mrem/yr) from airborne emissions (40 CFR Part 61). The population of noninvolved workers would be approximately 2,600. The resulting collective dose would be about 0.0034 person-rem/yr.

General Public. The locations of the MEI for the general public are either at or near the site boundary. Although other exposure pathways are also considered, inhalation exposure accounts for more than 95% of the total dose. The radiation dose for the MEI would be negligible, 0.0088 mrem/yr, compared with the dose limit of 10 mrem/yr from airborne emissions. The potential radiation dose resulting from drinking contaminated surface water would be two orders of magnitude less than that from exposure to airborne emissions.

For a population of about 630,000 persons within a 50-mile (80-km) distance from the site boundary, the collective dose would be about 0.039 person-rem/yr, which corresponds to about 2×10^{-5} LCF per year (less than 1 chance in 50,000 of 1 LCF per year in the population).

5.3.1.1.2 Conversion to UO_2

Conversion to UO_2 would result in average radiation exposure of less than 340 mrem/yr to involved workers and 0.03 mrem/yr or less to noninvolved workers and members of the public, similar to those for conversion to U_3O_8. The radiation doses and cancer risks associated with normal operations of the UO_2 conversion facilities are listed in Tables 5.4 and 5.5, respectively.

Involved Workers. The estimated collective dose for involved workers ranges from 49 to 54 person-rem/yr, slightly greater than conversion to U_3O_8. This would result in approximately 0.02 excess cancer fatality per year (2 LCFs over a 100-year period). If evenly distributed among involved workers (about 160 to 270 workers), the average individual dose would range from about 180 to 340 mrem/yr, well below the annual worker dose limit of 5,000 mrem/yr. This corresponds to an average cancer risk of 7×10^{-5} to 1×10^{-4} per year (less than 1 chance in 10,000 of developing 1 LCF per year).

Noninvolved Workers. The doses to noninvolved workers are similar to but slightly higher than those for conversion to U_3O_8. The dose to the MEI would range from 9.7×10^{-3} to 0.019 mrem/yr, which is negligible compared with the dose limit of 10 mrem/yr for airborne emissions. For a representative population size of about 2,600, the collective dose would range from 0.0068 to 0.013 person-rem/yr. The estimated number of potential LCFs would be less than 5×10^{-6} per year.

General Public. The estimated radiation dose to the MEI for the general public would be slightly higher than that from conversion to U_3O_8, ranging from 0.017 to 0.033 mrem/yr. These values are well below the radiation dose limit of 10 mrem/yr set for airborne emissions. The radiation dose from drinking contaminated surface water would be very small compared with the dose from airborne emissions. The collective dose for a population of approximately 630,000 persons would range from 0.078 to 0.15 person-rem/yr. This would correspond to 4×10^{-5} to 7×10^{-5} LCF per year among the population (less than 1 chance in 10,000 of 1 LCF per year).

5.3.1.1.3 Conversion to Metal

Conversion to uranium metal would result in average exposure of less than 240 mrem/yr to involved workers and less than 0.03 mrem/yr to noninvolved workers and members of the public. The radiological impacts and cancer risks from operations of the metal conversion facilities are shown in Tables 5.4 and 5.5, respectively.

Involved Workers. The collective dose to involved workers would range from 33 to 67 person-rem/yr, similar to conversion to U_3O_8 and conversion to UO_2. The corresponding number of LCFs would range from 0.01 to 0.03 per year (1 to 3 LCFs over a 100-year period) among a worker population of approximately 140 to 270. If evenly distributed among workers, the average annual worker dose would be about 240 mrem/yr, which is well below the regulatory limit of 5,000 mrem/yr. The corresponding cancer risk is 0.0001 per year (less than 1 chance in 10,000 of developing 1 LCF per year).

Noninvolved Workers. The radiation dose to noninvolved workers would be similar to those for conversion to U_3O_8 and conversion to UO_2 and would be negligible compared with the regulatory dose limit of 10 mrem/yr. The collective dose would range from 0.0015 to 0.01 person-rem/yr for approximately 2,600 workers.

General Public. The radiation dose for the MEI of the general public would range from 0.0037 to 0.026 mrem/yr, which corresponds to a cancer risk of 2×10^{-9} to 1×10^{-8} per year (less than 1 chance in 100 million of developing 1 LCF per year). The radiation dose from drinking contaminated surface water would be very small compared with the dose from airborne emissions. The collective dose for the population of about 630,000 people living within 50 miles (80 km) of the site would range from 0.017 to 0.12 person-rem/yr. This corresponds to about 8×10^{-6} to 6×10^{-5} LCF per year within the exposed population.

5.3.1.1.4 Cylinder Treatment Facility

The empty UF_6 cylinders from the conversion facilities would be decontaminated at a cylinder treatment facility before reuse or final disposal. Average radiological exposure incurred by involved workers would be less than 200 mrem/yr, and maximum exposures incurred by noninvolved workers and the off-site public would be less than 3×10^{-5} mrem/yr. The estimated radiological impacts and cancer risks from cylinder treatment operations are presented in Tables 5.4 and 5.5, respectively.

Involved Workers. The average annual dose received by involved workers would be approximately 160 mrem/yr, which was calculated by evenly distributing the estimated collective dose of 16 person-rem/yr to a worker population of approximately 100. The average dose is a small fraction of the dose limit of 5,000 mrem/yr and corresponds to a cancer risk of 6×10^{-5} per year (1 chance in 16,000 of developing 1 LCF per year). The collective number of LCFs among the involved workers would be 6×10^{-3} per year.

Noninvolved Workers. Only a small amount of U_3O_8 (0.01 lb/yr) would be released to the atmosphere from the cylinder treatment facility. Radiological exposure to the noninvolved worker MEI would be negligible (less than 1.5×10^{-5} mrem/yr). The collective dose would be about 1.0×10^{-5} person-rem/yr for a population of about 2,600.

General Public. The radiation exposure of the general public MEI from normal operations at the treatment facility would be negligible (less than 2.7×10^{-5} mrem/yr). The collective dose to the off-site population of 630,000 people would be less than 1.2×10^{-4} person-rem/yr.

5.3.1.2 Chemical Impacts

Potential chemical impacts to human health from normal operations at the conversion facilities would result primarily from exposure to trace amounts of insoluble uranium compounds (i.e., UO_2, U_3O_8, and UF_4) and HF released from process exhaust stacks. Risks from normal operations were quantified on the basis of calculated hazard indices. Information on the exposure assumptions, health effects assumptions, reference doses used for uranium compounds and HF, and calculational methods used in the chemical impact analysis are provided in Appendix C of the PEIS and Cheng et al. (1997).

Conversion to U_3O_8, UO_2, or metal would result in very low-level exposures to hazardous chemicals. No adverse health effects would be expected during normal operations. Hazardous chemical human health impacts resulting from normal operations of the conversion facilities are summarized in Table 5.6. The hazard indices for all conversion processes are more than 5,000 times lower than the hazard index of 1, which is the level at which adverse health effects might be expected to occur in some exposed individuals. The range of chemical exposures to the noninvolved workers and general public results from the different conversion technologies assessed.

One of the UO_2 conversion options, the gelation process, would also generate emissions of the chemical trichloroethylene from the process stack. The estimated increased lifetime carcinogenic risk of cancer incidence for noninvolved workers and members of the general public from exposure to trichloroethylene would be less than 1×10^{-8}, a very small increased risk that would not be considered an adverse impact.

The empty UF_6 cylinders from the conversion facilities would be decontaminated at a cylinder treatment facility prior to addition to the DOE scrap metal inventory. Estimates of the hazardous chemical impacts to human health resulting from cylinder treatment operations are also summarized in Table 5.6. The hazard indices from the cylinder treatment facility would be hundreds of times lower than those predicted for the conversion options, for which no adverse human health impacts were predicted.

5.3.2 Human Health — Accident Conditions

A range of accidents covering the spectrum from high-frequency/low-consequence accidents to low-frequency/high-consequence accidents has been presented in the engineering analysis report (LLNL 1997). These accidents are listed in Table 5.7. The following sections present the results for radiological and chemical health impacts of the highest-consequence accident in each frequency category, with the Portsmouth site used as representative. Results for all accidents listed in Table 5.7 are presented in Policastro et al. (1997). A detailed description of the methodology and assumptions used in the calculations is also provided in Appendix C of the PEIS and Policastro et al. (1997).

TABLE 5.6 Chemical Impacts to Human Health for Conversion/Treatment Options under Normal Operations at the Portsmouth Site[a]

	Impacts to Receptor			
	Noninvolved Workers[b]		General Public	
Option	Hazard Index for MEI[c,d]	Population Risk[e] (persons at risk/yr)	Hazard Index for MEI[c,f]	Population Risk[e] (persons at risk/yr)
Conversion to U_3O_8	3.9×10^{-7}– 8.0×10^{-7}	–	3.4×10^{-5} – 7.1×10^{-5}	–
Conversion to UO_2	7.5×10^{-7} – 1.2×10^{-6}	–	6.6×10^{-5} – 1.1×10^{-4}	–
Conversion to metal	4.7×10^{-7} – 9.6×10^{-7}	–	4.1×10^{-5} – 8.2×10^{-5}	–
Cylinder treatment	1.5×10^{-9}	–	7.0×10^{-8}	–

[a] Impacts are reported as ranges, which result from variations in the different conversion technologies within each option.

[b] Noninvolved workers include individuals who work at the facility but are not directly involved in handling hazardous materials and individuals who work on-site but not within the facility.

[c] The hazard index is an indicator for potential adverse health effects other than cancer; a hazard index greater than 1 indicates a potential for adverse health effects and a need for further evaluation. Hazard indices were calculated for combined exposures to uranium compounds and HF.

[d] The MEI for the noninvolved workers was assumed to be located on-site 100 m or more from the release point at the location that would result in the largest exposure from airborne emissions, including inhalation and incidental ingestion of contaminated soil.

[e] Calculation of population risk is not applicable when the corresponding hazard index for the MEI is less than 1.

[f] The MEI for the general public was assumed to be located off-site at the location that would result in the largest exposures through inhalation and ingestion of soil and drinking water.

TABLE 5.7 Accidents Considered for the Conversion Options

Option/Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to U_3O_8					
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Cylinder valve shear	A single UF_6 cylinder is mishandled, etc., resulting in the shearing of the cylinder valve and loss of solid UF_6 from the valve onto the ground.	UF_6	0.25	120 (continuous)	Ground
HF system leak during upgrading of HF to anhydrous HF	An HF absorber column line leaks 5% of its flowing contents due to potential vessel, pump, or pipe leakage.	HF	216	15	Stack
HF system leak during HF neutralization	An HF distillation column line leaks 5% of its flowing contents due to potential vessel, pump, or pipe leakage.	HF	10	15	Stack
Loss of cooling water during upgrading of HF to anhydrous HF	Cooling water is lost to the HF distillation column condenser, and HF vapor is removed by a limestone bed before reaching the environment.	HF	22	2	Stack
Loss of cooling water during HF neutralization	Cooling water is lost to the absorption column coolers, and HF vapor is released to the atmosphere.	HF	19	2	Stack
Loss of off-site electrical power	Off-site electrical power is lost, which halts facility operations but does not result in significant releases to the environment.	No release	NA[b]	NA	NA
U_3O_8 drum spill	A single U_3O_8 drum is damaged by a forklift and spills its contents onto the floor inside the storage facility.	U_3O_8	0.00014	30	Stack
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Ammonia release	An ammonia fill line is momentarily disconnected, and ammonia is released at grade.	Ammonia	255	1	Ground
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
HF pipeline rupture	An earthquake ruptures an underground pipeline transporting HFs, releasing it to the ground.	HF	500	10	Soil
HF storage tank overflow	An HF storage tank overflows during filling, spilling onto the floor; the pool of HF evaporates and is released through the building stack.	HF	45	15	Stack

TABLE 5.7 (Cont.)

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to U_3O_8 (Cont.)					
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in.-deep water pool.	HF	150	60 (continuous)	Ground
Earthquake	The U_3O_8 storage building is damaged during a design-basis earthquake, and 10% of the stored drums are breached.	U_3O_8	41	30	Ground
Hydrogen explosion	Due to equipment malfunction, hydrogen that accumulated in the conversion reactor ignites and causes the reactor to rupture.	U_3O_8 HF	0.27 7	30	Stack
Tornado	A windblown missile from a design-basis tornado pierces a single U_3O_8 drum in the U_3O_8 storage building.	U_3O_8	69	0.5	Ground
Vehicle-induced fire, 3 full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground
Incredible Accidents (frequency: less than 1 in 1 million years)					
Anhydrous HF tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled anhydrous HF storage tank.	HF	7,920	120	Ground
Ammonia tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled ammonia storage tank.	Ammonia	118,000	20	Ground
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA
Small plane crash, 2 full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,190	0 to 30 30 to 121	Ground

TABLE 5.7 (Cont.)

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to UO_2					
Likely Accidents (frequency: 1 or more times in 100 years)					
Ammonia stripper overpressure	Cooling water is lost to the ammonia stripping column, and ammonia vapor is released to the atmosphere.	Ammonia	15	1	Ground
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Cylinder valve shear	A single UF_6 cylinder is mishandled, etc., resulting in shearing of the cylinder valve and loss of solid UF_6 from the valve onto the ground.	UF_6	0.25	120 (continuous)	Ground
HF system leak during upgrading of HF to anhydrous HF	An HF absorber line leaks 5% of its flowing contents due to potential vessel, pump, or pipe leakage.	HF	216	15	Stack
HF system leak during HF neutralization	An HF distillation column line leaks 5% of its flowing contents due to potential vessel, pump, or pipe leakage.	HF	10	15	Stack
Loss of cooling water during upgrading of HF to anhydrous HF	Cooling water is lost to the HF distillation column condenser, and HF vapor is removed by a limestone bed before reaching the environment.	HF	22	2	Stack
Loss of cooling water during HF neutralization	Cooling water is lost to the absorption column coolers, and HF vapor is released to the atmosphere.	HF	19	2	Stack
Loss of off-site electrical power	Off-site electrical power is lost, which halts facility operations but does not result in significant releases to the environment.	No release	NA	NA	NA
Trichloroethylene (TCE) spill	A TCE storage tank spills onto the floor during operations, and the pool of TCE evaporates and is released to the environment.	TCE	120	120	Stack
Trichloroethylene vapor leak	The exhaust line from the gel sphere dryers leaks 5% of its flowing contents due to potential pipe leakage.	TCE	20	60	Stack
UO_2 drum spill	A single UO_2 drum is damaged by a forklift and spills its contents onto the floor inside the storage facility.	UO_2	0.000056	30	Stack

TABLE 5.7 (Cont.)

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to UO_2 (Cont.)					
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Ammonia release	An ammonia fill line is momentarily disconnected, and ammonia is released at grade.	Ammonia	255	1	Ground
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
HF pipeline rupture	An earthquake ruptures an underground pipeline transporting HF, releasing it to the ground.	HF	500	10	Soil
HF storage tank overflow	An HF storage tank overflows during filling, spilling onto the floor; the pool of HF evaporates and is released to the indoor air of the process building.	HF	45	15	Stack
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in.-deep water pool.	HF	147	60 (continuous)	Ground
Earthquake	The UO_2 storage building is damaged during a design-basis earthquake, and 10% of the stored drums are breached.	UO_2	9.8	30	Ground
Hydrogen explosion	Due to equipment malfunction, hydrogen that accumulated in the ceramic UO_2 conversion reactor ignites and causes the reactor to rupture.	UO_2 HF	0.25 7	30	Stack
Hydrogen explosion	Due to equipment malfunction, hydrogen that accumulated in the gelation conversion reactor ignites and causes the reactor to rupture.	UO_2	0.017	30	Stack
Tornado	A windblown missile from a design-basis tornado pierces a single ceramic UO_2 drum in the UO_2 storage building.	UO_2	3.7	0.5	Ground
Tornado	A windblown missile from a design-basis tornado pierces a single UO_2 drum produced by gelation in the UO_2 storage building.	UO_2	5.6	0.5	Ground
Vehicle-induced fire, 3 full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground

TABLE 5.7 (Cont.)

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to UO_2 (Cont.)					
Incredible Accidents (frequency: less than 1 in 1 million years)					
Anhydrous HF tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled anhydrous HF storage tank.	HF	7,920	120	Ground
Ammonia tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled ammonia storage tank.	Ammonia	117,920	20	Ground
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA
Small plane crash, 2 full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,190	0 to 30 30 to 121	Ground
Conversion to Metal					
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Cylinder valve shear	A single UF_6 cylinder is mishandled, etc., resulting in shearing of the cylinder valve and loss of solid UF_6 from the valve onto the ground.	UF_6	0.25	120 (continuous)	Ground
HF system leak	An off-gas line from the conversion reactor to the condenser leaks 5% of its flowing contents due to potential vessel, pump, or pipe leakage.	HF	3.6	15	Stack
Loss of cooling water	Cooling water is lost to the reactor HF coolers, and HF vapor is released to the atmosphere.	HF	17	2	Stack
Loss of off-site electrical power	Off-site electrical power is lost, which halts facility operations but does not result in significant releases to the environment.	No release	NA	NA	NA
UF_4 drum spill	A single UF_4 drum is damaged by a forklift and spills its contents onto the floor of the process building.	UF_4	0.00015	30	Stack

TABLE 5.7 (Cont.)

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to Metal (Cont.)					
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Ammonia release	An ammonia fill line is momentarily disconnected, and ammonia is released at grade.	Ammonia	255	1	Ground
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
HF pipeline rupture	An earthquake ruptures an underground pipeline transporting HF and releasing it to the ground.	HF	500	10	Soil
HF storage tank overflow	An HF storage tank overflows during filling, spilling onto the floor; the pool of HF evaporates and is released to the indoor air of the process building.	HF	45	15	Stack
Nitric acid (HNO_3) release	Due to equipment failure, hot HNO_3 flows through a relief valve.	HNO_3	6	2	Stack
Uranium metal fire	The wooden boxes containing the uranium metal product burn, affecting a total of 34 uranium derbies.	U_3O_8	0.058	30	Stack
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in.-deep water pool.	HF	147	60 (continuous)	Ground
Earthquake	The uranium product storage building is damaged during a design-basis earthquake, and some of the boxes containing uranium metal are breached.	U_3O_8	0.058	30	Ground
Hydrogen explosion	Due to equipment malfunction, hydrogen that accumulated in the conversion reactor ignites and causes the reactor to rupture.	UF_4 HF	0.05 2	30	Stack
Reactor rupture	A reactor containing molten uranium metal is damaged or breached, releasing hot molten uranium metal as airborne particles.	U_3O_8	0.0026	15	Stack
Tornado	A design-basis tornado does not result in significant releases because uranium is in metal form.	No release	NA	NA	NA
Vehicle-induced fire, 3 full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground

TABLE 5.7 (Cont.)

Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Conversion to Metal (Cont.)					
Incredible Accidents (frequency: less than 1 in 1 million years)					
Anhydrous HF tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled anhydrous HF storage tank.	HF	7,920	120	Ground
Ammonia tank rupture	Large seismic or beyond-design-basis event causes rupture of a filled ammonia storage tank.	Ammonia	118,000	20	Ground
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA
Small plane crash, 2 full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,190	0 to 30 30 to 121	Ground
Cylinder Treatment Facility					
Likely Accidents (frequency: 1 or more times in 100 years)					
Loss of off-site electrical power	Off-site electrical power is lost, which halts facility operations but does not result in significant releases to the environment.	No release	NA	NA	NA
U_3O_8 drum spill	A single U_3O_8 drum is damaged by a forklift and spills its contents onto the ground outside the storage facility.	U_3O_8	0.138	30	Ground
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Loss of scrubber water	Water is lost to both HF scrubbers, and HF is released with the off gas.	HF	26	30	Stack
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Depleted UF_6 cylinder rupture	A truck crashes into the depleted UF_6 heel storage pad, damaging two cylinders; the fuel from the truck ignites and releases all of the depleted UF_6.	UO_2F_2 HF	38.5 10	30	Ground
Earthquake	The solids product building is damaged during a design-basis earthquake, and 50% of the stored drums are breached.	U_3O_8	1.9	30	Ground
HF aqueous tank rupture	The evaporator tank fails, releasing its entire contents of HF to the floor; the pool of aqueous HF evaporates and is released to the indoor air of the process building.	HF	3.4	60	Stack
Tornado	A windblown missile from a design-basis tornado pierces a single U_3O_8 drum in the solids product building.	U_3O_8	69	0.5	Ground
Incredible Accidents (frequency: less than 1 in 1 million years)					
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA

[a] Ground-level releases were assumed to occur outdoors on concrete pads in the cylinder storage yards. To prevent contaminant migration, cleanup of residuals was assumed to begin immediately after the release was stopped.

[b] NA = not applicable.

5.3.2.1 Radiological Impacts

Table 5.8 lists the radiological doses to various receptors for the accidents that give the highest dose from each frequency category. The LCF risks for these accidents are given in Table 5.9. The doses and the risks are presented as ranges (maximum and minimum) because two different meteorological conditions and two or three technologies were considered for each conversion option. The doses and risks presented here were obtained by assuming that the accidents would occur. The probability of occurrence for each accident is indicated by the frequency category to which it belongs. For example, accidents in the extremely unlikely category have a probability of occurrence of between 1 in 10,000 and 1 in 1 million per year. The following conclusions may be drawn from the radiological health impact results:

- No cancer fatalities would be predicted from any of the accidents.

- The maximum radiological dose to noninvolved worker and general public MEIs (assuming that an accident occurred) would be 9.2 rem. This dose is less than the 25-rem dose recommended for assessing the adequacy of protection of public health and safety from potential accidents by the NRC (1994).

- The overall radiological risk to noninvolved worker and general public MEI receptors (estimated by multiplying the risk per occurrence [Table 5.9] by the annual probability of occurrence by the number of years of operations) would be less than 1 for all of the conversion facility accidents.

5.3.2.2 Chemical Impacts

The accidents considered in this section are listed in Table 5.7. The results of the accident consequence modeling in terms of chemical impacts are presented in Tables 5.10 and 5.11. The results are presented as (1) number of people with potential for adverse effects and (2) number of people with potential for irreversible adverse effects. The tables present the results for the accident within each frequency category that would affect the largest number of people (total of workers and off-site population) (Policastro et al. 1997). The numbers of noninvolved workers and members of the off-site public represent the impacts if the associated accident was assumed to occur. The accidents listed in Tables 5.10 and 5.11 are not identical because an accident with the largest impacts for adverse effects might not lead to the largest impacts for irreversible adverse effects. The impacts may be summarized as follows:

- If the accidents identified in Tables 5.10 and 5.11 did occur, the number of persons in the off-site population with potential for adverse effects would range from 0 to 18,000 (maximum corresponding to HF tank rupture), and the number of off-site persons with potential for irreversible adverse effects would range from 0 to 1,200 (maximum corresponding to ammonia tank rupture).

TABLE 5.8 Estimated Radiological Doses per Accident Occurrence for the Conversion Options at the Portsmouth Site

		Maximum Dose[c]				Minimum Dose[c]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Option/Accident[a]	Frequency Category[b]	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)
Conversion to U_3O_8									
Corroded cylinder spill, dry conditions	L	7.7×10^{-2}	7.1	2.2×10^{-3}	1.4×10^{-1}	3.3×10^{-3}	2.8×10^{-1}	9.3×10^{-5}	2.2×10^{-2}
Earthquake	EU	9.2	8.4×10^{2}	2.6×10^{-1}	9.8	3.3×10^{-1}	3.3×10^{1}	1.1×10^{-2}	2.5
Small plane crash, 2 full 48G cylinders	I	6.6×10^{-3}	1.5	4.3×10^{-3}	1.8×10^{-1}	8.7×10^{-4}	2.3×10^{-1}	6.2×10^{-4}	2.5×10^{-2}
Conversion to UO_2									
Corroded cylinder spill, dry conditions	L	7.7×10^{-2}	7.1	2.2×10^{-3}	1.4×10^{-1}	3.3×10^{-3}	2.8×10^{-1}	9.3×10^{-5}	2.2×10^{-2}
Earthquake	EU	2.3	2.1×10^{2}	6.4×10^{-2}	2.4	9.6×10^{-2}	8.2	2.7×10^{-3}	6.2×10^{-1}
Small plane crash, 2 full 48G cylinders	I	6.6×10^{-3}	1.5	4.3×10^{-3}	1.8×10^{-1}	8.7×10^{-4}	2.3×10^{-1}	6.2×10^{-4}	2.5×10^{-2}
Conversion to metal									
Corroded cylinder spill, dry conditions	L	7.7×10^{-2}	7.1	2.2×10^{-3}	1.4×10^{-1}	3.3×10^{-3}	2.8×10^{-1}	9.3×10^{-5}	2.2×10^{-2}
Uranium metal fire	U	2.4×10^{-6}	1.1×10^{-4}	2.6×10^{-6}	9.5×10^{-3}	4.9×10^{-7}	2.4×10^{-11}	2.0×10^{-6}	4.2×10^{-3}
Vehicle-induced fire, 3 full 48G cylinders	EU	2.0×10^{-2}	4.5	1.3×10^{-2}	2.7×10^{1}	3.7×10^{-3}	5.2×10^{-1}	1.9×10^{-3}	5.2×10^{-1}
Small plane crash, 2 full 48G cylinders	I	6.6×10^{-3}	1.5	4.3×10^{-3}	1.8×10^{-1}	8.7×10^{-4}	2.3×10^{-1}	6.2×10^{-4}	2.5×10^{-2}
Cylinder treatment									
U_3O_8 drum spill	L	3.1×10^{-2}	2.8	8.7×10^{-4}	3.3×10^{-2}	1.3×10^{-1}	1.1×10^{-1}	3.7×10^{-5}	8.4×10^{-3}
Tornado[d]	EU	4.3×10^{-1}	3.8×10^{1}	1.2×10^{-2}	1.2	4.3×10^{-1}	3.8×10^{1}	1.2×10^{-2}	1.2

[a] The bounding accident chosen to represent each frequency category is the one that would result in the highest dose to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[b] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations ($> 10^{-2}$/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations ($10^{-2} - 10^{-4}$/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} - 10^{-6}$/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations ($< 10^{-6}$/yr).

[c] Maximum and minimum doses reflect differences in assumed technologies and meteorological conditions at the time of the accident, assumed to occur at the center of the Portsmouth site. In general, maximum doses would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum doses would occur under D stability with 4 m/s wind speed.

[d] Meteorological conditions analyzed for the tornado were D stability with 20 m/s wind speed.

TABLE 5.9 Estimated Radiological Health Risks per Accident Occurrence for the Conversion Options at the Portsmouth Site[a]

		Maximum Risk (LCFs)[d]				Minimum Risk (LCFs)[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Option/Accident[b]	Frequency Category[c]	MEI	Population	MEI	Population	MEI	Population	MEI	Population
Conversion to U_3O_8									
Corroded cylinder spill, dry conditions	L	3×10^{-5}	3×10^{-3}	1×10^{-6}	7×10^{-5}	1×10^{-6}	1×10^{-4}	5×10^{-8}	1×10^{-5}
Earthquake	EU	4×10^{-3}	3×10^{-1}	1×10^{-4}	5×10^{-3}	2×10^{-4}	1×10^{-2}	6×10^{-6}	1×10^{-3}
Small plane crash, 2 full 48G cylinders	I	3×10^{-6}	6×10^{-4}	2×10^{-6}	9×10^{-5}	3×10^{-7}	9×10^{-5}	3×10^{-7}	1×10^{-5}
Conversion to UO_2									
Corroded cylinder spill, dry conditions	L	3×10^{-5}	3×10^{-3}	1×10^{-6}	7×10^{-5}	1×10^{-6}	1×10^{-4}	5×10^{-8}	1×10^{-5}
Earthquake	EU	9×10^{-4}	8×10^{-2}	3×10^{-5}	1×10^{-3}	4×10^{-5}	3×10^{-3}	1×10^{-6}	3×10^{-4}
Small plane crash, 2 full 48G cylinders	I	3×10^{-6}	6×10^{-4}	2×10^{-6}	9×10^{-5}	3×10^{-7}	9×10^{-5}	3×10^{-7}	1×10^{-5}
Conversion to metal									
Corroded cylinder spill, dry conditions	L	3×10^{-5}	3×10^{-3}	1×10^{-6}	7×10^{-5}	1×10^{-6}	1×10^{-4}	5×10^{-8}	1×10^{-5}
Uranium metal fire	U	1×10^{-9}	4×10^{-8}	1×10^{-9}	5×10^{-6}	2×10^{-10}	1×10^{-14}	1×10^{-9}	2×10^{-6}
Vehicle-induced fire, 3 full 48G cylinders	EU	8×10^{-6}	2×10^{-3}	6×10^{-6}	1×10^{-2}	1×10^{-6}	3×10^{-4}	1×10^{-6}	3×10^{-4}
Small plane crash, 2 full 48G cylinders	I	3×10^{-6}	6×10^{-4}	2×10^{-6}	9×10^{-5}	3×10^{-7}	9×10^{-5}	3×10^{-7}	1×10^{-5}
Cylinder treatment									
U_3O_8 drum spill	L	1×10^{-5}	1×10^{-3}	4×10^{-7}	2×10^{-5}	5×10^{-7}	4×10^{-5}	2×10^{-8}	4×10^{-6}
Tornado[d]	EU	2×10^{-4}	2×10^{-2}	6×10^{-6}	6×10^{-4}	2×10^{-4}	2×10^{-2}	6×10^{-6}	6×10^{-4}

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (LCFs) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one that would result in the highest risks to the general public MEI. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum risks reflect differences in assumed technologies and meteorological conditions at the time of the accident, assumed to occur at the center of the Portsmouth site. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] Meteorological conditions analyzed for the tornado were D stability with 20 m/s wind speed.

TABLE 5.10 Number of Persons with Potential for Adverse Effects from Accidents under the Conversion Options at the Portsmouth Site[a]

		Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Option/Accident[b]	Frequency Category[c]	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Conversion to U_3O_8									
Corroded cylinder spill, dry conditions	L	Yes	240	No	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	520	Yes	10	Yes	190	No	0
Vehicle-induced fire, 3 full 48G cylinders	EU	Yes	260	Yes	580	Yes	2	Yes	4
HF tank rupture	I	Yes	740	Yes	18,000	Yes	810	Yes	19
Conversion to UO_2									
Corroded cylinder spill, dry conditions	L	Yes	240	No	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	520	Yes	10	Yes	190	No	0
Vehicle-induced fire, 3 full 48G cylinders	EU	Yes	260	Yes	580	Yes	2	Yes	4
HF tank rupture	I	Yes	740	Yes	18,000	Yes	810	Yes	19
Conversion to metal									
Corroded cylinder spill, dry conditions	L	Yes	240	No	0	Yes	2	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	520	Yes	10	Yes	190	No	0
Vehicle-induced fire, 3 full 48G cylinders	EU	Yes	260	Yes	580	Yes	2	Yes	4
HF tank rupture	I	Yes	740	Yes	18,000	Yes	810	Yes	19
Cylinder treatment									
U_3O_8 drum spill[f]	L	No	0	No	0	No	0	No	0
Loss of scrubber water[f]	U	No	0	No	0	No	0	No	0
Tornado[g]	EU	Yes	1	No	0	NA[h]	NA	NA	NA

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site population) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum values reflect differences in assumed meteorological conditions at the time of the accident, assumed to occur at the center of the site. In general, the maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas the minimum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either "Yes" or "No" for potential adverse effects to an individual.

[f] These accidents would result in the largest plume sizes, although no people would be affected.

[g] Meteorological conditions analyzed for the tornado were D stability with 20 m/s wind speed.

[h] NA = not applicable.

TABLE 5.11 Number of Persons with Potential for Irreversible Adverse Effects from Accidents under the Conversion Options at the Portsmouth Site[a]

Option/Accident[b]	Frequency Category[c]	Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
		MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Conversion to U_3O_8									
Corroded cylinder spill, dry conditions	L	Yes	3	No	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	370	Yes[f]	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	440	Yes[f]	0	Yes	4	No	0
Ammonia tank rupture	I	Yes	460	Yes	1,200	Yes	270	Yes	9
Conversion to UO_2									
Ammonia stripper overpressure	L	Yes	40	Yes[f]	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	370	Yes[f]	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	440	Yes[f]	0	Yes	4	No	0
Ammonia tank rupture	I	Yes	460	Yes	1,200	Yes	270	Yes	9
Conversion to metal									
Corroded cylinder spill, dry conditions	L	Yes	3	No	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	370	Yes[f]	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	440	Yes[f]	0	Yes	4	No	0
Ammonia tank rupture	I	Yes	460	Yes	1,200	Yes	270	Yes	9
Cylinder treatment									
U_3O_8 drum spill[g]	L	No	0	No	0	No	0	No	0
Loss of scrubber water[g]	U	No	0	No	0	No	0	No	0
Tornado[h]	EU	Yes[f]	0	No	0	NA[i]	NA	NA	NA

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site population) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations ($> 10^{-2}$/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations ($10^{-2} – 10^{-4}$/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} – 10^{-6}$/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations ($< 10^{-6}$/yr).

[d] Maximum and minimum values reflect different meteorological conditions at the time of the accident, assumed to occur at the center of the site. In general, the maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas the minimum risks would occur under D stability with 4 m/s wind speed. An exception is worker impacts for the ammonia tank rupture, for which maximum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either "Yes" or "No" for potential irreversible adverse affects to an individual.

[f] MEI locations were evaluated at 100 m from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the worker and general public population distributions for the site were used, which did not show receptors at the MEI locations.

[g] These accidents would result in the largest plume sizes, although no people would be affected.

[h] Meteorological conditions analyzed for the tornado were D stability with 20 m/s wind speed.

[i] NA = not applicable.

- If the accidents identified in Tables 5.10 and 5.11 did occur, the number of noninvolved workers with potential for adverse effects would range from 0 to 740 (maximum corresponding to HF tank rupture), and the number of noninvolved workers with potential for irreversible adverse effects would range from 0 to 460 (maximum corresponding to ammonia tank rupture).

- The largest impacts would be caused by HF tank rupture; corroded cylinder spill, wet conditions – rain and water pool; ammonia tank rupture; and vehicle-induced fire involving three full 48G cylinders. Accidents involving stack emissions would have very small impacts compared with accidents involving releases at ground level due to the large dilution (and lower source terms due to filtration and deposition) involved with the stack emissions.

- The bounding accidents for the conversion options (conversion to U_3O_8, UO_2, and metal) would have nearly identical impacts.

- For the most severe accidents in each frequency category, the noninvolved worker MEI and the public MEI would have the potential for both adverse effects and irreversible adverse effects. The likely accidents for each conversion option (frequency of more than one chance in 100 per year) would result in no potential adverse or irreversible adverse effects for the general public. The generally reduced impacts to the public MEI compared with the noninvolved worker MEI are related to dispersion of the chemical release with downwind distance (except for UF_6 cylinder fire with plume rise).

- The maximum risk was computed as the product of the consequence (number of people) times the frequency of occurrence (per year) times the number of years of operations (20 years, 2009 through 2028). The results indicate that the maximum risk values would be less than 1 for all accidents except the following:

  - *Potential Adverse Effects:*

    Corroded cylinder spill, dry conditions (L, likely), workers
    Corroded cylinder spill, wet conditions – rain (U, unlikely), workers

  - *Potential Irreversible Adverse Effects:*

    Corroded cylinder spill, dry conditions (L, likely), workers
    Ammonia stripper overpressure (L, likely), workers
    Corroded cylinder spill, wet conditions – rain (U, unlikely), workers

These risk values are conservative because the numbers of people affected were based on assuming (1) meteorological conditions that would result in the maximum reasonably foreseeable plume size (i.e., F stability and 1 m/s wind speed) and (2) wind in the direction that would lead to maximum numbers of individuals exposed for noninvolved workers or for the general population.

To aid in the interpretation of accident analysis results, the number of fatalities potentially associated with the estimated irreversible adverse effects was calculated. For the worker and general public accidents involving UF_6 releases shown in Table 5.10, exposure to HF and uranium compounds could be high enough to result in death for 1% or less of the persons experiencing irreversible adverse effects (Policastro et al. 1997). Thus, for the corroded cylinder spill accidents having a range of 0 to 440 irreversible adverse effects for noninvolved workers, approximately 0 to 4 worker deaths would be expected; no deaths would be expected for members of the general public from such accidents. For the ammonia tank rupture accident caused by an earthquake, exposure to ammonia would result in death for about 2% of the persons experiencing irreversible adverse effects. This would correspond to about 5 to 9 deaths among noninvolved workers and 0 to 24 deaths for the general public. These are the maximum potential consequences of the accidents; the upper ends of the ranges result from assuming worst-case weather conditions, with the wind blowing in the direction where the highest number of people would be exposed.

5.3.2.3 Physical Hazards

The risk of on-the-job fatalities and injuries to all conversion facility workers was calculated using industry-specific statistics from the U.S. Bureau of Labor Statistics, as reported by the National Safety Council (1995). Annual fatality and injury rates for construction and manufacturing, respectively, were used for the construction and operational phases of the conversion facility lifetime.

No on-the-job fatalities are predicted for any of the options analyzed, but a range of about 300 to 500 injuries is predicted during the conversion facility lifetimes. Overall, the largest impacts are predicted for conversion to UO_2 through gelation and for conversion to metal through batch reduction because these options require larger numbers of employees. All other conversion options would result in similar impacts; fewer impacts are predicted for the cylinder treatment facility (i.e., approximately 170 injuries).

Because the conversion technologies analyzed for conversion of U_3O_8 would employ almost the same number of workers, there are essentially no differences between them. There would be a probability of about 0.35 of an on-the-job fatality (sum of 0.18 for the construction phase and 0.17 for the operations phase) for the U_3O_8 conversion options (Table 5.12). The predicted injury incidence would be about 285 injuries over the lifetime of the facility.

TABLE 5.12 Potential Impacts to Human Health from Physical Hazards under Accident Conditions for the Conversion Options[a]

	Impacts to Conversion Facility Workers[b]			
	Incidence of Fatalities		Incidence of Injuries	
Option	Construction	Operations	Construction	Operations
Conversion to U_3O_8	0.18	0.16–0.17	66	215–219
Conversion to UO_2	0.22–0.30	0.18–0.29	79–108	243–384
Conversion to metal	0.22–0.25	0.17–0.30	79–92	222–395
Cylinder treatment	0.08	0.11	30	140

[a] Impacts are reported as ranges, which result from variations in the employment requirements for the different conversion technologies for each option.

[b] Potential hazards were estimated for all conversion facility workers.

Source: Injury and fatality rates used in calculations taken from National Safety Council (1995).

The predicted probability of worker fatalities for conversion to UO_2 ranges from 0.4 to 0.59 (Table 5.12). The predicted injury incidence ranges from about 320 to 492 injuries over the lifetime of the UO_2 conversion facility. The upper ends of the ranges result from the larger number of workers required for operation of the gelation facility.

The predicted probability of worker fatalities for conversion to metal ranges from about 0.4 to 0.55 (Table 5.12). The predicted injury incidence ranges from about 300 to 490 injuries over the lifetime of the metal conversion facility. The upper ends of the ranges result from the larger number of workers required for operation of the batch reduction facility.

For the cylinder treatment facility option, the probability of an on-the-job fatality is about 0.19 (sum of 0.08 for the construction phase and 0.11 for the operations phase) (Table 5.12). The estimated injury incidence would be about 170 over the lifetime of the facility.

5.3.3 Air Quality

Additional details regarding the analysis of air quality impacts for the conversion option are presented in Tschanz (1997a).

5.3.3.1 Construction

The annual emissions of SO_x, NO_x, hydrocarbons (HC), CO, and PM_{10} expected during conversion plant construction are listed in Table 5.13. The estimated 1-hour maximum pollutant concentrations at the facility boundary during construction are shown in Table 5.14. Additional estimates were made for the conversion technology that had the highest estimated 1-hour maximum pollutant concentrations (i.e., gelation); these estimated concentrations are given in Table 5.15. Although all of these pollutant concentrations would be much higher than those for plant operations, they would remain below ambient air quality standards. One possible exception is PM_{10}, for which concentrations were estimated to be about 50% of the 24-hour standard of 150 : g/m^3. Some fugitive dust control measures would be necessary to mitigate this potentially high concentration. Construction of the conversion plant in a region of already high, even if compliant, ambient pollutant concentrations might require consideration of changes and/or controls for the emission of the other pollutants as well.

Estimated emissions from the cylinder treatment facility for all aspects of construction and operations are of the same order of magnitude (generally about 0.4 to 0.7 times as large) as those associated with the baseline cylinder transfer facility (see Section 4.3.3), and the cylinder treatment facility area would be about half as large as the baseline cylinder transfer facility area. Except for the 1-hour average results, the analytical results shown in Table 5.16 for the cylinder treatment facility are about 0.2 to 0.4 times as large as those shown in Table 4.7 of this document for the cylinder transfer facility. The 1-hour average impacts of construction of a cylinder treatment facility would be essentially the same as those for cylinder transfer facility construction.

TABLE 5.13 Emissions to the Atmosphere from Construction of a Depleted UF_6 Conversion Plant during the Peak Year

	Emissions to Atmosphere (tons/yr)				
Option	SO_2	NO_2	HC	CO	PM_{10}
Conversion to U_3O_8	2	28	8	190	40–50
Conversion to UO_2	2–3	30–46	8–13	200–320	50–60
Conversion to metal	2–3	30–40	8–12	200–270	50–60

Source: LLNL (1997).

TABLE 5.14 Maximum 1-Hour Average Pollutant Concentrations at the Nearest Point on the Boundary from Construction of a Conversion Facility at the Portsmouth Site[a]

	Pollutant (: g/m^3)				
Option	SO_2	NO_2	HC	CO	PM_{10}
Conversion to U_3O_8	25	350	100	2,400	500
Conversion to UO_2	24–36	370–560	100–160	2,400–3,800	610–720
Conversion to metal	24–35	360–470	100–140	2,400–3,100	600–710

[a] The ranges shown for some pollutants include results from the various technologies used for the conversion option.

TABLE 5.15 Maximum Air Quality Impacts from Conversion Facility Construction[a]

	Estimated Pollutant Emissions[b]							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
Pollutant	Concen-tration[c] (: g/m^3)	Fraction of Standard[d]	Concen-tration[c] (: g/m^3)	Fraction of Standard[d]	Concen-tration[c] (: g/m^3)	Fraction of Standard[d]	Concen-tration[c] (: g/m^3)	Fraction of Standard[d]
CO	3,430	0.09	910	0.09	–	–	–	–
NO_x	–	–	–	–	–	–	6.7	0.067
SO_2	–	–	–	–	3.3	0.009	0.4	0.005
PM_{10}	–	–	–	–	77	0.51	8.8	0.18

[a] Estimated pollutant emissions are given for the conversion to UO_2 gelation option, which would have the highest emissions.

[b] Values are listed only for pollutant/averaging time period combinations that have applicable air quality standards.

[c] Concentrations are the second highest values estimated for one entire year. Short-term standards are not to be exceeded more than once per year.

[d] Ratio of the concentration to the respective air quality standard. A ratio of less than 1 indicates that the standard would not be exceeded. Pollutant/averaging time period combinations for which no air quality standard exists are noted with a dash (-).

TABLE 5.16 Air Quality Impacts from Construction of the Cylinder Treatment Facility

	Estimated Pollutant Emissions							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
Pollutant	Range[a] (: g/m^3)	Fraction of Standard[b]	Range[a] (: g/m^3)	Fraction of Standard[b]	Range[a] (: g/m^3)	Fraction of Standard[b]	Range[a] (: g/m^3)	Fraction of Standard[b]
CO	1,800	0.045	310	0.031	120	–	10	–
NO_x	280	–	47	–	19	–	1.5	0.015
PM_{10}	390	–	65	–	26	0.17	2.1	0.042

[a] Concentrations are the second highest values estimated for one entire year. Short-term standards are not to be exceeded more than once per year.

[b] Ratio of the upper end of the concentration range to the respective air quality standard. A ratio of less than 1 indicates that the standard is not exceeded. Pollutant/averaging time period combinations for which no air quality standard exists are noted with a dash (–).

5.3.3.2 Operations

Hourly emission rates during operations were determined from annual emission rates given in the engineering analysis report (LLNL 1997); these rates are shown in Table 5.17. The methods used to analyze the impacts of pollutant emissions are described in Appendix C of the PEIS. All air pollutant concentrations during operations would be well below applicable ambient air quality standards for all conversion options. The maximum ground-level atmospheric concentrations at the site boundary from boiler stack and generator emissions are listed in Tables 5.18 through 5.20. The nearest any of the criteria pollutant concentrations would come to a corresponding air quality standard is the annual NO_x concentration, which would be about 0.0006 of the standard for all conversion options.

Maximum air quality impacts from the process stacks are also listed in Tables 5.18 through 5.20. The batch conversion to uranium metal is the only case for which NO_x would be emitted from the process stack, and the NO_x emission rate from the process stack in that case would be about six times larger than from the boiler stack. Nevertheless, the estimated maximum annual NO_x concentration at the site boundary is less than 1% of the state standard. Ohio has no ambient air quality standards for HF or uranium compounds.

Each emergency generator would operate for 300 hours or less during 1 year. When it was operating, however, an emergency generator would produce higher concentrations of criteria

TABLE 5.17 Emissions to the Atmosphere from Operation of a Depleted UF_6 Conversion Plant

	Emissions to Atmosphere (lb/yr)						
Option/Source	SO_2	NO_2	HC	CO	PM_{10}	HF	Uranium Compounds
Conversion to U_3O_8							
Boiler stack	60–80	8,300–10,000	180–200	4,100–5,000	310–400	–	–
Process stack	–	–	–	–	–	300–900	3.3 U_3O_8
Generator stack	60	400	400	2,300	80	–	–
Conversion to UO_2							
Boiler stack	23–820	3,800–110,000	170–2,300	800–55,000	290–4,100	–	–
Process stack	–	–	–	–	–	300–900	2.5–12 UO_2
Generator stack	54–80	400–720	400–690	2,300–3,700	20–140	–	–
Conversion to metal							
Boiler stack	60–100	8,200–14,000	170–290	4,000–6,700	300–500	–	–
Process stack	–	117,000	–	–	–	300	1.2–9.6 U_3O_8; 3.8 UF_4
Generator stack	54–60	460–600	410–490	2,700–3,600	90–120	–	–

Source: LLNL (1997).

pollutants at the facility boundaries than would the boiler. The estimated pollutant concentrations from the generator are listed in Tables 5.18 through 5.20. Compared with the air quality standards, the estimated concentrations are no more than 2% of allowed values.

The boiler stack parameters are identical for the cylinder treatment facility and the baseline cylinder transfer facility (Section 4.3.3). Given the similarities in the input data, the results of the air quality analyses for the two facilities should be expected to be comparable. Although not presented explicitly here, the same can be said of the impacts for operations. In summary, all of the criteria pollutant impacts of the cylinder treatment facility would not differ substantially from those of the cylinder transfer facility; all of the impacts not explicitly noted here are considered to be negligible. The only pollutant of concern emitted by the cylinder treatment facility process stack would be HF, and it, too, would be comparable for the two facilities. The cylinder treatment facility process stack would produce maximum annual average HF concentrations of 1.6×10^{-6} : g/m^3. This concentration is several orders of magnitude smaller than any applicable HF air quality standard.

No quantitative estimate was made of the impacts on the criterion pollutant ozone. Ozone formation is a regional issue that would be affected by emissions data for the entire area around a proposed conversion site. The pollutants most related to ozone formation that would result from the

TABLE 5.18 Air Quality Impacts from Operations for Conversion to U_3O_8

Option/ Stack/ Pollutant	Estimated Pollutant Emissions[a]							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]
Conversion to U_3O_8 with Anhydrous HF								
Boiler stack								
CO	0.99	2×10^{-5}	0.38	4×10^{-5}	–	–	–	–
NO_x	–	–	–	–	–	–	0.059	0.0006
Generator stack								
CO	360	0.009	78	0.008	–	–	Not calculated	
NO_x	–	–	–	–	–	–	Not calculated	
Process stack								
HF	–	–	–	–	0.030	NS[d]	0.0045	NS
U_3O_8	–	–	–	–	–	–	1.6×10^{-5}	NS
Conversion to U_3O_8 with HF Neutralization								
Boiler stack								
CO	0.87	2×10^{-5}	0.33	3×10^{-5}	–	–	–	–
NO_x	–	–	–	–	–	–	0.052	0.0005
Generator stack								
CO	360	0.009	78	0.008	–	–	Not calculated	
NO_x	–	–	–	–	–	–	Not calculated	
Process stack								
HF	–	–	–	–	0.0094	NS	0.0014	NS
U_3O_8	–	–	–	–	–	–	1.5×10^{-5}	NS

[a] Values are listed only for pollutant/averaging time period combinations with air quality standards.

[b] Concentrations are the second highest values estimated for one entire year. Short-term standards are not to be exceeded more than once per year.

[c] Ratio of the upper end of the concentration range to the respective air quality standard. A ratio of less than 1 indicates that the standard is not exceeded.

[d] NS = No air quality standard is available.

TABLE 5.19 Air Quality Impacts from Operations for Conversion to UO_2

	Estimated Pollutant Emissions[a]							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
Option/ Stack/ Pollutant	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]
Conversion to UO_2 with Anhydrous HF								
Boiler stack								
CO	0.81	2×10^{-5}	0.32	3×10^{-5}	–	–	–	–
NO_x	–	–	–	–	–	–	0.049	0.0005
Generator stack								
CO	560	0.014	140	0.014	–	–	Not calculated	
NO_x	–	–	–	–	–	–	Not calculated	
Process stack								
HF	–	–	–	–	0.024	NS[d]	0.0035	NS
U_3O_8	–	–	–	–	–	–	5×10^{-5}	NS
Conversion to UO_2 with HF Neutralization								
Boiler stack								
CO	0.76	2×10^{-5}	0.29	3×10^{-5}	–	–	–	–
NO_x	–	–	–	–	–	–	0.046	0.0005
Generator stack								
CO	560	0.014	140	0.014	–	–	Not calculated	
NO_x	–	–	–	–	–	–	Not calculated	
Process stack								
HF	–	–	–	–	0.0078	NS	0.0012	NS
U_3O_8	–	–	–	–	–	–	4.6×10^{-5}	NS
Conversion to UO_2 with Gelation Process								
Boiler stack								
CO	1.7	4×10^{-5}	0.71	1×10^{-4}	–	–	–	–
NO_x	–	–	–	–	–	–	0.058	0.0006
Generator stack								
CO	NA[e]	NA	NA	NA	NA	NA	NA	NA
NO_x	NA	NA	NA	NA	NA	NA	NA	NA
Process stack								
HF	–	–	–	–	0.016	NS	0.0022	NS
U_3O_8	–	–	–	–	–	–	1.0×10^{-5}	NS

[a] Values are listed only for pollutant/averaging time period combinations with air quality standards.

[b] Concentrations are the second highest values estimated for one entire year. Short-term standards are not to be exceeded more than once per year.

[c] Ratio of the upper end of the concentration range to the respective air quality standard. A ratio of less than 1 indicates that the standard is not exceeded.

[d] NS = No air quality standard is available.

[e] NA = Data not available.

TABLE 5.20 Air Quality Impacts from Operations for Conversion to Uranium Metal

Option/ Stack/ Pollutant	Estimated Pollutant Emissions[a]							
	1-Hour Average		8-Hour Average		24-Hour Average		Annual Average	
	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]	Range[b] (: g/m^3)	Fraction of Standard[c]
Batch Process								
Boiler stack								
CO	0.89	2×10^{-5}	0.37	4×10^{-5}	–	–	–	–
NO_x	–	–	–	–	–	–	0.055	0.0006
Generator stack								
CO	590	0.015	150	0.015	–	–	Not calculated	
NO_x	–	–	–	–	–	–	Not calculated	
Process stack								
HF	–	–	–	–	0.0067	NS[d]	0.00098	NS
UF_4	–	–	–	–	–	–	1.2×10^{-5}	NS
U_3O_8	–	–	–	–	–	–	3.1×10^{-5}	NS
NO_2	–	–	–	–	–	–	0.38	0.004
Continuous Process								
Boiler stack								
CO	0.76	2×10^{-5}	0.29	3×10^{-5}	–	–	–	–
NO_x	–	–	–	–	–	–	0.046	0.0005
Generator stack								
CO	560	0.014	140	0.014	–	–	Not calculated	
NO_x	–	–	–	–	–	–	Not calculated	
Process stack								
HF	–	–	–	–	0.0079	NS	0.0012	NS
UF_4	–	–	–	–	–	–	1.5×10^{-5}	NS
U_3O_8	–	–	–	–	–	–	4.8×10^{-6}	NS

[a] Values are listed only for pollutant/averaging time period combinations with air quality standards.

[b] Concentrations are the second highest values estimated for one entire year. Short-term standards are not to be exceeded more than once per year.

[c] Ratio of the upper end of the concentration range to the respective air quality standard. A ratio of less than 1 indicates that the standard is not exceeded.

[d] NS = No air quality standard is available.

conversion of depleted UF_6 are HC and NO_x. In later Phase II studies, when specific technologies and sites would be selected, the potential effects on ozone of these pollutants at a proposed site could be put in perspective by comparing them with the total emissions of HC and NO_x in the surrounding area. Small additional contributions to the totals would be unlikely to alter the ozone attainment status of the region.

5.3.4 Water and Soil

This section discusses impacts of the conversion options on surface water, groundwater, and soils, with the Portsmouth site used as a representative conversion site. The impacts are evaluated over a range of conditions present at the representative sites and are also relevant for a similarly sized generic site located in the vicinity of a river that could be used to supply water for construction and normal operations and to receive liquid waste discharges. The major conversion option parameters are summarized in Table 5.21.

5.3.4.1 Surface Water

The methodology used to determine potential impacts to surface water for each conversion technology is described in Appendix C of the PEIS and Tomasko (1997b).

5.3.4.1.1 Conversion to U_3O_8

Construction. Construction of a U_3O_8 conversion facility at the Portsmouth site would produce increased runoff to nearby surface waters because of replacing soil and vegetation with either buildings or paved areas, approximately 13 acres (5.3 ha) (LLNL 1997). The amount of increased runoff would be negligible compared with the assumed existing area for runoff (about 0.3% of the site area). None of the construction activities would measurably affect floodplains.

Table 5.21 shows the quantity of water that would be used during construction of the U_3O_8 conversion facility (about 8 million gal/yr). This water would be pumped from underlying groundwater aquifers. If the rate of water consumption was constant, the average rate of withdrawal would be about 15 gpm. Although the Portsmouth site has the ability to use Scioto River water, all water is currently obtained from groundwater wells. Therefore, there would be no impacts to the Scioto River.

For construction, the net volume of water disposed of would be about 4 million gal/yr (7.6 gpm) (Table 5.21). The primary contaminants of concern would be construction chemicals, organics, and some suspended solids. The wastewater would be discharged to nearby surface waters under an NPDES permit, or to an appropriate wastewater sewer. By following good engineering

TABLE 5.21 Summary of Conversion Option Parameters Affecting Water Quality and Soil[a]

Option	Disturbed Land Area (acres)	Operations Area (acres)	Construction Water (million gal/yr)	Operations Water (million gal/yr)
Conversion to U_3O_8	20	13	Raw = 8 Waste = 4	Raw = 34 – 47 Waste = 15 – 23 Sanitary = 1.2
Conversion to UO_2	22 – 31	14 – 20	Raw = 4 – 12 Waste = 5 – 6	Raw = 41 – 285 Waste = 9.7 – 135 Sanitary = 0.7 – 2.3
Conversion to metal	23 – 26	15 – 16	Raw = 10 – 12 Waste = 5 – 6	Raw = 55 Waste = 25 – 26 Sanitary = 1.4 – 2.3

Option	Accident Scenario	Radioactive Release to Surface Water[a] (Ci/yr)	Radioactive Effluent Concentration[b] (pCi/L)	Dilution Factor[c]	Surface Water Concentration (pCi/L)
Conversion to U_3O_8	HF pipeline break	0.001	12 – 17	47,000 – 4,200,000	4.1×10^{-6} – 2.6×10^{-4}
Conversion to UO_2	HF pipeline break	0.002 – 0.003	6 – 21	42,000 – 500,000	1.2×10^{-5} – 5.0×10^{-4}
Conversion to metal	HF pipeline break	0.001 – 0.002	10 – 21	42,000 – 2,600,000	4.0×10^{-6} – 4.9×10^{-4}

[a] Data from engineering analysis report (LLNL 1997).

[b] Concentration derived from estimated annual radioactive release and annual wastewater discharge.

[c] Dilution factor based on average flow conditions in receiving rivers.

practices (e.g., stockpiling materials away from surface water drainages, covering construction piles with tarps to prevent erosion by precipitation, and cleaning up small chemical spills as soon as they occur), concentrations in the wastewater would be small (well below any drinking water criteria).

Once in the surface water, mixing and dilution of the pollutants would occur. This dilution would be greater than 275,000:1 for average flow conditions in the Scioto River. This amount of dilution would reduce any contamination present to concentrations well below regulatory standards. Because the concentration of contamination in the water would be very low, impacts to sediment in the streams would also be negligible.

Operations. For normal operations, no impacts would occur to surface runoff, and there would be no measurable impacts on floodplains (effluent discharges to surface waters less than 0.002% of the average flow in the Scioto River). As indicated in Table 5.21, normal operation of the U_3O_8 conversion facility would require at most 47 million gal/yr (approximately 89 gpm) of raw water. Because this water would be obtained from wells, there would be no impacts to surface waters.

A maximum of 23 million gal/yr of wastewater would be generated during operations, including cooling tower blowdown, process water, and industrial waste water. Another 1.2 million gal/yr of sanitary wastewater would be produced (Table 5.21). For constant rates of discharge, about 44 gpm of wastewater and 2.3 gpm of sanitary water would be released to the environment at approved NPDES locations, producing negligible impacts.

The primary contaminants of concern for the wastewater would be uranium and chemicals used to inhibit rust, reduce friction, and enhance heat exchange (e.g., copolymers, phosphates, phosphonates, calcium, magnesium, nitrates, sodium, and potassium). As discussed in the engineering analysis report (LLNL 1997), approximately 0.001 Ci/yr of uranium with an activity of 4×10^{-7} Ci/g would be released in the discharge water. For a waste volume of 23 million gal/yr (Table 5.21), the uranium concentration in the effluent would be about 30 :g/L. After dilution in nearby surface water, the concentration would be much less than the proposed EPA drinking water standard for uranium of 20 :g/L, used here for comparison. Concentrations of the other chemicals released would also be expected to be very low and within the guidelines of an NPDES permit.

Accident Scenarios. Most of the accidents analyzed would involve outdoor releases on impermeable concrete pads in the cylinder yards; such releases could be cleaned up with little loss of the contaminated material to the soil. The only postulated accident that would release contaminated water to the environment is an HF pipeline break produced by an earthquake (Table 5.21). Anhydrous HF would be pumped from the process building to the HF storage building through an underground pipeline that would carry liquid HF at a rate of 10 gpm (0.63 L/s) through 200 ft (61 m) of 1-in. (2.5-cm) pipe. For this accident scenario, 100% of the HF would drain into the ground at a point 3 ft (0.91 m) below grade during a 10-minute period. Approximately 500 lb (227 kg) of liquid HF (60 gal [227 L]) would be released. After 48 hours, the contaminated soil was assumed to be removed. Because of the rapid response to the accident, the HF would have little time to travel into the soil. For a silty sand soil, the travel distance would be about 2 ft (6.1 m) (Tomasko 1997b). Removal of the contaminated soil and soil water would prevent any contamination problems to the groundwater and would prevent any cross contamination with surface waters. Therefore, there would be no net impact from this accident. Because this accident scenario would not affect surface runoff or existing floodplains, impacts to these parameters would also be nonexistent.

5.3.4.1.2 Conversion to UO_2

The environmental parameters associated with the UO_2 conversion alternatives are similar to those for U_3O_8 conversion (Table 5.21), except for raw water use, which would be about five times larger for normal operations. Because water would be withdrawn from wells, there would be no surface water impacts. Because of this option's similarities to the U_3O_8 conversion option, impacts to surface water produced by UO_2 conversion would be essentially the same as those for U_3O_8 conversion (i.e., negligible).

As was the case for the conversion to U_3O_8 option, discharge waters would contain from 0.002 to 0.003 Ci/yr. For the water volumes listed in Table 5.21, the equivalent concentrations would range from 6 to 76 pCi/L (30 to 400 :g/L). After dilution, concentrations would be much less than the EPA proposed drinking water standard for uranium of 20 :g/L, used here for comparison.

5.3.4.1.3 Conversion to Metal

The environmental parameters associated with conversion to metal are very similar to those for U_3O_8 conversion (Table 5.21); however, raw water usage for construction and normal operation would be about 50% higher. Because the construction water and water for normal operations would be obtained from wells, there would be no impacts to surface water.

As was the case for the conversion to U_3O_8 and UO_2 options, discharge waters would contain either 0.001 or 0.002 Ci/yr. For the water volumes listed in Table 5.21, the equivalent concentrations would range from 25 to 53 :g/L. After dilution, the concentrations would be much less than the EPA proposed drinking water standard for uranium of 20 :g/L, used here for comparison.

5.3.4.1.4 Cylinder Treatment

Construction and operation of the cylinder treatment facility would use less land and water and produce less wastewater than the construction and operation of conversion facilities, as shown in Table 5.22. Thus, potential impacts would be smaller. There are no postulated accidents that would directly release contaminants to surface water (LLNL 1997).

5.3.4.2 Groundwater

The methodology for assessing impacts to groundwater for each conversion technology is described in detail in Appendix C of the PEIS and Tomasko (1997b).

TABLE 5.22 Summary of Environmental Parameters for the Cylinder Treatment Facility

Parameter	Construction	Operations	Accidents
Land area (acres)	8.7	4.5	None
Disturbed land (acres)	4.5	4.5	None
Water (million gal/yr)	3.6	3.4	None
Wastewater[a] (million gal/yr)	1.3	2.3	None

[a] Includes sanitary wastewater, cooling tower blowdown, industrial water, and process water.

5.3.4.2.1 Conversion to U_3O_8

Potential impacts to groundwater could occur during construction, normal operations, and postulated accident scenarios. These impacts include the following: changes in effective recharge to underlying aquifers; changes in the depth to groundwater; changes in the direction of groundwater flow; and changes in groundwater quality.

Because construction water would be supplied from underlying aquifers, approximately 15 gpm would be withdrawn. This withdrawal represents a 0.2% increase in extraction over a current daily use of 14 million gal and would produce a negligible impact on the groundwater system. Groundwater quality could also be impacted by construction activities. For example, exposed chemicals could be mobilized by precipitation and infiltrate the surficial aquifers. By following good engineering and construction practices (e.g., covering chemicals to prevent interaction with rainfall, promptly cleaning up any chemical spills, and providing retention basins to catch and hold any contaminated runoff), groundwater concentrations would be less than the EPA guidelines.

Normal operations of the conversion facility would require about 65 gpm of raw water (Table 5.21). If pumped from wells in the surficial aquifers, the impact would be negligible (0.7% increase in extraction). Because discharges to groundwater are not planned for normal operations, there would be no direct impacts to groundwater quality. Potential impacts could be derived from interaction with surface water; however, because impacts to surface water are negligible, impacts to groundwater via a surface water pathway would be even less.

As discussed in Section 5.3.4.1.1, only one accident scenario, the HF pipeline break, would potentially release contaminants to the groundwater (Table 5.21). Because of rapid mitigation and the small volume of HF in the release, this scenario would have a negligible impact on groundwater quality and would not affect recharge, depth to groundwater, or direction of flow.

5.3.4.2.2 Conversion to UO_2

The environmental parameters associated with the UO_2 conversion alternatives are very similar to those for U_3O_8 conversion (Table 5.21), except for raw water use during normal operations (about five times larger). If water were obtained from underlying aquifers, pumping would represent an increase of about 4% of the current groundwater use. These impacts would be negligible.

5.3.4.2.3 Conversion to Metal

The environmental parameters associated with the metal conversion alternatives are very similar to those for U_3O_8 conversion (Table 5.21), except for a 50% increase in raw water use during construction and normal operations. Because the water for construction and normal operations was obtained from underlying aquifers, pumping would increase by 0.3% during construction, and by 1.1% of the current use for normal operations. These impacts would be negligible.

During construction, groundwater concentrations would be kept below EPA guidelines (EPA 1996) by following good engineering practices. During normal operations, there would be no impacts to groundwater quality because direct discharges to groundwater are not planned.

5.3.4.2.4 Cylinder Treatment Facility

For the cylinder treatment facility, construction would require about 6.8 gpm and normal operations would use about 6.5 gpm of groundwater. Impacts to groundwater during construction of the cylinder treatment facility would include changes in effective recharge, changes in the depth to the water table, changes in the direction of groundwater flow, and changes in quality. At most, the groundwater use for construction or normal operations would represent a 0.07% increase in daily use, which would have a negligible impact.

Construction of the cylinder treatment facility would decrease the permeability of about 4.5 acres (1.8 ha) of land because of paving and building. This loss of permeable land would reduce recharge, increase the depth to the water table, and change the direction of groundwater flow; however, because the area affected would be small (about 0.1% of the land area available), these impacts would be negligible and limited to small, local regions in the immediate vicinity of the paved lots and building footprints.

During construction, groundwater quality could also be impacted. For example, stockpiled chemicals could be mobilized by precipitation and infiltrate the surficial aquifers. By following good engineering and construction practices (e.g., covering chemicals to prevent interaction with rain, promptly cleaning up any chemical spills, and providing retention basins to catch and hold any contaminated runoff), groundwater concentrations would be less than the EPA guidelines.

5.3.4.3 Soil

The methodology for estimating potential impacts to soil is described in detail in Appendix C of the PEIS and Tomasko (1997b).

5.3.4.3.1 Conversion to U_3O_8

Potential impacts to soil could occur during construction, normal operations, and postulated accident scenarios. These impacts include changes in topography, permeability, quality, and erosion potential.

Paving and construction would alter about 13 acres (5.3 ha) and potentially disturb up to 20 acres (8.1 ha) (LLNL 1997). Soil beneath the buildings and paved areas may be altered permanently. Although the alteration of these lands might be permanent, the net impact would be negligible in comparison to the land area involved (0.3% of the land area available). A larger percentage is associated with the potential land area disturbed (about 0.5% of the land area available). These impacts could include increased permeability, modification of the local topography, changes in the soil chemistry, and increases in the potential for soil erosion. These impacts would, however, be insignificant on a sitewide scale. In addition, impacts to these areas would be mitigated with time (e.g., disturbed soil would be regraded to natural contours and seeded with natural vegetation, thereby returning the soils to their original condition).

By following good engineering practices (e.g., disturbing as little soil as possible, contouring and reseeding disturbed lands, scheduling construction activities to minimize land disturbance, controlling runoff, using tarps to prevent chemical/precipitation interactions, and cleaning up any spills as soon as they occurred), negligible impacts to soils should occur.

Because normal operations would not affect soil, there would be no soil impacts. The only accident identified that could potentially impact the soil is an HF pipeline rupture (Table 5.21), discussed in Section 5.3.4.1.1. Because of rapid mitigation (any contaminated soil would be cleaned up within 48 hours of the rupture) and the small release volume (60 gal of HF), impacts to the soil would be negligible.

5.3.4.3.2 Conversion to UO_2

The environmental parameters associated with the UO_2 conversion alternatives are very similar to those for U_3O_8 conversion (Table 5.21). Because of these similarities, impacts to soil for UO_2 conversion would be negligible.

5.3.4.3.3 Conversion to Metal

The environmental parameters associated with the metal conversion alternatives are very similar to those for U_3O_8 conversion (Table 5.21). Because of these similarities, impacts to soils would be essentially the same as those previously presented, i.e., none to negligible.

5.3.4.3.4 Cylinder Treatment Facility

For the cylinder treatment facility, the only impacts would occur during construction. There would be no discharges to the ground under normal operations, and there are no accidents identified in LLNL (1997) that would lead to direct contamination of the soil. Impacts from construction would include changes in topography, permeability, quality, and erosion potential. By following good engineering and construction practices (e.g., covering chemicals with tarps, cleaning up chemical spills as soon as they occur, and providing retention basins to catch and hold any contaminated surface runoff), impacts to soil quality would be negligible.

5.3.5 Socioeconomics

The impact of each conversion option on socioeconomic activity was estimated for an ROI surrounding the Portsmouth site. The assessment methodology is discussed in Appendix C of the PEIS and Allison and Folga (1997).

Each of the conversion options is likely to have a small impact on socioeconomic conditions in the ROI surrounding the site described in Section 2.8. This is largely because a major proportion of the expenditures associated with procurement for the construction and operation of each technology option flows outside the ROI to other locations in the United States, reducing the concentration of local economic effects of each conversion option.

Slight changes in employment and income would occur in the ROI as a result of local spending of personal consumption expenditures derived from employee wages and salaries, local procurement of goods and services required to construct and operate each conversion option, and other local investment associated with construction and operation. In addition to creating new (direct) jobs at the site, each conversion option would also create indirect employment and income in the ROI as a result of jobs and procurement expenditures. Jobs and income created directly by each conversion option, together with indirect activity in the ROI, would contribute slightly to reduction in unemployment in the ROI surrounding the site. Minimal impacts are expected on local population growth, and consequently on local housing markets and local fiscal conditions.

The effects of constructing and operating each conversion technology on regional economic activity (measured in terms of employment and personal income) and on population, housing, and local public revenues and expenditures are described in Sections 5.3.5.1 through 5.3.5.4. Impacts are presented as ranges to include impacts that would occur with each conversion option and for the cylinder treatment facility at the site. Impacts are presented for the peak year of construction (assumed to be 2007); operations values are averages for the period 2009 through 2028. The potential impacts for each conversion option and for the cylinder treatment facility are presented in Table 5.23.

5.3.5.1 Conversion to U_3O_8

During the peak year of construction of a U_3O_8 conversion facility, between 240 and 250 direct jobs would be created at the site and 170 to 190 additional jobs would be created indirectly in the site ROI (Table 5.23) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, 410 to 440 jobs would be created. Construction activity would also produce direct and indirect income in the ROI surrounding the site, with total income of $14 million during the peak year. During the first year of operations of the U_3O_8 conversion facility, 440 to 450 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with total income of $14 million annually. Construction and operation of the conversion facility would result in an increase in the projected baseline compound annual average growth rate in ROI employment of less than 0.1 percentage point from 1999 through 2028.

Construction of the U_3O_8 conversion facility would be expected to generate direct in-migration of 330 to 340 people in the peak year of construction at the site. Additional indirect job in-migration would also be expected in the site ROIs, bringing the total number of in-migrants to between 440 and 460 in the peak year (Table 5.23). Operation of the U_3O_8 conversion facility would be expected to generate direct and indirect job in-migration of 310 in the first year of operations. Construction and operation of the facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of less than 0.1 percentage point from 1998 through 2028.

A U_3O_8 conversion facility would generate a demand for 160 to 170 additional rental housing units during the peak year of construction (Table 5.23), representing an impact of 8.2–8.6% on the projected number of vacant rental housing units in the site ROI. A demand for 110 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 2.4% on the number of vacant owner-occupied housing units in the ROI.

During the peak year of construction, 440 to 460 people would be expected to in-migrate into the ROI at the site, leading to an increase of about 0.2% over forecasted baseline revenues and expenditures in the site ROI (Table 5.23). In the first year of operations, 310 in-migrants would be expected, leading to an increase of about 0.2% in local revenues and expenditures.

TABLE 5.23 Potential Socioeconomic Impacts of the Conversion Options for the Portsmouth Site

	Conversion to U_3O_8		Conversion to UO_2	
	Construction[a]	Operations[b]	Construction[a]	Operations[b]
Economic activity in the ROI				
Direct jobs	240 – 250	200 – 210	330 – 630	230 – 360
Indirect jobs	170 – 190	240	230 – 410	310 – 560
Total jobs	410 – 440	440 – 450	560 – 1,000	500 – 950
Income ($ million)				
Direct income	11	10	15 – 28	11 – 18
Total income	14	14	19 – 35	16 – 27
Population in-migration into the ROI	440 – 460	310	610 – 1,100	280 – 980
Housing demand				
Number of units in the ROI	160 – 170	110	220 – 410	100 – 360
Public finances				
Change in ROI fiscal balance (%)	0.2	0.2	0.3 – 0.5	0.1 – 0.5

	Conversion to Uranium Metal		Cylinder Treatment Facility	
	Construction[a]	Operations[b]	Construction[a]	Operations[b]
Economic activity in the ROI				
Direct jobs	380 – 440	210 – 370	100	130
Indirect jobs	230 – 250	310 – 420	50	130
Total jobs	610 – 690	520 – 790	150	260
Income ($ million)				
Direct income	12 – 16	10 – 18	5	10
Total income	15 – 21	15 – 25	5	13
Population in-migration into the ROI	690 – 750	350 – 580	170	280
Housing demand				
Number of units in the ROI	250 – 270	130 – 210	60	100
Public finances				
Change in ROI fiscal balance (%)	0.3 – 0.4	0.2 – 0.3	0.1	0.1

[a] Impacts are for the peak year of construction, 2007. Socioeconomic impacts were assessed for 1999 through 2008.

[b] Impacts are the annual averages for operations for the period 2009 through 2028.

5.3.5.2 Conversion to UO_2

During the peak year of construction of a UO_2 conversion facility, 330 to 630 direct jobs would be created at the site and 230 to 410 additional jobs indirectly in the site ROI (Table 5.23) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, 560 to 1,000 jobs would be created. Construction activity would also produce direct and indirect income in the ROI surrounding the site, with total income ranging from \$19 million to \$35 million during the peak year. During the first year of operations of the UO_2 conversion facility, 500 to 950 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with total income ranging from \$16 million to \$27 million. Construction and operation of the conversion facility would result in an increase in the projected baseline compound annual average growth rate in ROI employment less than 0.1 percentage point from 1999 through 2028.

Construction of the UO_2 conversion facility would be expected to generate direct in-migration of 460 to 860 people in the peak year of construction at the site. Additional indirect job in-migration would also be expected in the site ROIs, bringing the total number of in-migrants to between 610 and 1,100 in the peak year (Table 5.23). Operation of the UO_2 conversion facility would be expected to generate direct and indirect job in-migration of 280 to 980 in the first year of operations. Construction and operation of the facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of less than 0.1 percentage point from 1999 through 2028.

The UO_2 conversion facility would generate a demand for 220 to 410 additional rental housing units during the peak year of construction, representing an impact of 11.4 to 21.1% on the projected number of vacant rental housing units in the site ROI (Table 5.23). A demand for 110 to 360 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 2.9 to 7.6% on the number of vacant owner-occupied housing units in the ROIs.

During the peak year of construction, 610 to 1,100 people would be expected to in-migrate into the ROI at the site, leading to increases of 0.3 to 0.5% over forecasted baseline revenues and expenditures in the site ROI (Table 5.23). In the first year of operations, 280 to 980 in-migrants would be expected, leading to increases of 0.1 to 0.5% in local revenues and expenditures.

5.3.5.3 Conversion to Metal

During the peak year of construction of a metal conversion facility, 380 to 440 direct jobs would be created at the site and 230 to 250 additional jobs indirectly in the site ROI (Table 5.23) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, 610 to 690 jobs would be created. Construction activity would also produce direct and indirect income in the ROI surrounding the site, with total income ranging from $15 million to $21 million during the peak year. During the first year of operations of the metal conversion facility, 520 to 790 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with total income ranging from $15 million to $25 million. Construction and operation of the conversion facility would result in an increase in the projected baseline compound annual average growth rate in ROI employment of less than 0.1 percentage point from 1999 through 2028.

Construction of the metal conversion facility would be expected to generate direct in-migration of 520 to 600 people in the peak year of construction at the site. Additional indirect job in-migration would also be expected in the site ROI, bringing the total number of in-migrants to between 690 and 750 in the peak year (Table 5.23). Operation of the metal conversion facility would be expected to generate direct and indirect job in-migration of 350 to 580 in the first year of operations. Construction and operation of the facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of less than 0.1 percentage point from 1999 through 2028.

The metal conversion facility would generate a demand for 250 to 270 additional rental housing units during the peak year of construction, representing an impact of 13 to 14% on the projected number of vacant rental housing units in the site ROI (Table 5.23). A demand for 130 to 210 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 2.7 to 4.5% on the number of vacant owner-occupied housing units in the ROI.

During the peak year of construction, 690 to 750 people would be expected to in-migrate into the ROI surrounding the site, leading to increases of 0.3 to 0.4% over forecasted baseline revenues and expenditures in the site ROI (Table 5.23). In the first year of operations, 350 to 580 in-migrants would be expected, leading to increases of less than 0.2 to 0.3% in local revenues and expenditures.

5.3.5.4 Cylinder Treatment Facility

During the peak year of construction of a cylinder treatment facility, approximately 100 direct jobs would be created at the site and 50 additional jobs indirectly in the site ROI (Table 5.23) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, 150 jobs would be created. Construction activity would also produce direct and indirect income in the ROI surrounding the site, with total income of $5 million during the peak year. During the first year of operations of the cylinder treatment facility, 260 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI, with total income of $13 million. Construction and operation of the facility would result in an increase in the projected baseline compound annual average growth rate in ROI employment of less than 0.1 percentage point from 1999 through 2028.

Construction of the cylinder treatment facility would be expected to generate direct in-migration of 140 people in the peak year of construction at the site. Additional indirect job in-migration would also be expected in the site ROI, bringing the total number of in-migrants to 170 in the peak year (Table 5.23). Operation of the cylinder treatment facility would be expected to generate direct and indirect job in-migration of 280 in the first year of operations. Construction and operation of the facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of less than 0.1 percentage point from 1999 through 2028.

The cylinder treatment facility would generate a demand for 60 additional rental housing units during the peak year of construction, representing an impact of 3.2% on the projected number of vacant rental housing units in the site ROI (Table 5.23). A demand for 100 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 2.2% on the number of vacant owner-occupied housing units in the ROI.

During the peak year of construction, 170 people would be expected to in-migrate into the ROI surrounding the site, leading to increases of 0.1% over forecasted baseline revenues and expenditures in the site ROI (Table 5.23). In the first year of operations, 280 in-migrants would be expected, leading to increases of 0.1% in local revenues and expenditures.

5.3.6 Ecology

Moderate impacts to ecological resources could result from construction of a conversion facility. Impacts could include mortality of individual organisms, habitat loss, or changes in biotic communities. Impacts due to operation of a conversion facility would be negligible. Potential impacts to vegetation, wildlife, wetlands, and threatened and endangered species were assessed.

5.3.6.1 Conversion to U_3O_8

Site preparation for the construction of a facility to convert UF_6 to U_3O_8 would require the disturbance of approximately 20 acres (8 ha), including the permanent replacement of approximately 13 acres (5.3 ha) with structures and paved areas. Existing vegetation would be destroyed during land clearing activities. Determination of the vegetation communities that would be eliminated by site preparation would depend on the future location of the facility. Communities occurring on undeveloped land at the Portsmouth site are relatively common and well represented in the vicinity of the site. Impacts to high-quality native plant communities may occur if facility construction requires disturbance to vegetation communities outside of the currently fenced area. Construction of the conversion facility would not be expected to threaten the local population of any species. The loss of up to 20 acres (8 ha) of undeveloped land would constitute a moderate adverse impact. Erosion of exposed soil at construction sites could reduce the effectiveness of restoration efforts and create sedimentation downgradient of the site. The implementation of standard erosion control measures, installation of storm-water retention ponds, and immediate replanting of disturbed areas with native species would help minimize impacts to vegetation. Impacts due to facility construction are shown in Table 5.24.

Wildlife would be disturbed by land clearing, noise, and human presence. Wildlife with restricted mobility, such as burrowing species or juveniles of nesting species, would be destroyed during land clearing activities. More mobile individuals would relocate to adjacent available areas with suitable habitat. Population densities, and thus competition for food and nesting sites, would increase in these areas, potentially reducing the survivability or reproductive capacity of displaced individuals. Many wildlife species would be expected to quickly recolonize replanted areas near the conversion facility following completion of construction. The permanent loss of up to 13 acres (5.3 ha) of habitat would not be expected to threaten the local population of any wildlife species because similar habitat would be available in the vicinity of the site. Therefore, construction of a conversion facility for U_3O_8 production would be considered a moderate adverse impact to wildlife.

Impacts to surface water and groundwater quality during construction are expected to be negligible. Thus, construction-derived impacts to aquatic biota would also be expected to be negligible. Wetlands could potentially be impacted by filling or draining during construction. Impacts to wetlands due to alteration of surface water runoff patterns, soil compaction, or groundwater flow could occur if the conversion facility were located immediately adjacent to wetland areas. However, impacts to wetlands would be minimized by maintaining a buffer area around wetlands during construction of the facility. Unavoidable impacts to wetlands would require a *Clean Water Act* Section 404 permit, which might stipulate mitigative measures. Additional permitting might be required by state agencies.

Critical habitat has not been designated for any state or federally listed threatened or endangered species at the Portsmouth site. Prior to construction of a conversion facility, a site-specific survey for federal- and state-listed threatened, endangered, or candidate species or species of special concern would be conducted. Impacts to these species could thus be avoided or, where impacts were unavoidable, appropriate mitigation could be developed.

During operations, ecological resources in the vicinity of the conversion facility would be exposed to atmospheric emissions from the boiler stack and process stack; however, emission levels would be expected to be extremely low (Section 5.3.3.2). The highest annual average air concentration of U_3O_8 would be 4.5×10^{-8} mg/m^3. This would result in a radiation exposure to the general public (nearly 100% due to inhalation) of less than 0.009 mrem/yr (Section 5.3.1.1), well below the DOE guidelines of 100 mrem/yr (0.00027 rad/d). Wildlife species are less sensitive to radiation than

TABLE 5.24 Impacts to Ecological Resources from Construction of a Conversion Facility and Cylinder Treatment Facility

Option/Resource	Type of Impact	Degree of Impact
Conversion to U_3O_8		
Vegetation	Loss of 20 acres	Moderate adverse impact
Wildlife	Loss of 13 to 20 acres	Minor to moderate adverse impact
Wetlands	Loss, degradation	Potential adverse impact
Aquatic species	Water quality, habitat reduction	Negligible impact
Protected species	Destruction, habitat loss	Potential adverse impact
Conversion to UO_2		
Vegetation	Loss of 22 to 31 acres	Moderate adverse impact
Wildlife	Loss of 14 to 31 acres	Moderate adverse impact
Wetlands	Loss, degradation	Potential adverse impact
Aquatic species	Water quality, habitat reduction	Negligible impact
Protected species	Destruction, habitat loss	Potential adverse impact
Conversion to metal		
Vegetation	Loss of 23 to 26 acres	Moderate adverse impact
Wildlife	Loss of 15 to 26 acres	Moderate adverse impact
Wetlands	Loss, degradation	Potential adverse impact
Aquatic species	Water quality, habitat reduction	Negligible impact
Protected species	Destruction, habitat loss	Potential adverse impact
Cylinder treatment facility		
Vegetation	Loss of 9 acres	Moderate adverse impact
Wildlife	Loss of 5 to 9 acres	Moderate adverse impact
Wetlands	Loss, degradation	Potential adverse impact
Aquatic species	Water quality, habitat reduction	Negligible impact
Protected species	Destruction, habitat loss	Potential adverse impact

humans (proposed DOE guidelines would require an absorbed dose limit to terrestrial animals of 0.1 rad/d). Therefore, impacts to wildlife due to radiation effects would be expected to be negligible. Toxic effects of chronic inhalation of U_3O_8 are minor at a concentration of 17 mg/m^3 for tested animal species. This is many orders of magnitude greater than expected emissions. Therefore, toxic effects to wildlife due to U_3O_8 inhalation would also be expected to be negligible.

The maximum average air concentration of HF due to operation of a conversion facility would be 3.7×10^{-6} mg/m^3 (Section 5.3.3.2). Chronic exposure to HF gas produces only mild effects in tested animal species at concentrations as high as 7 mg/m^3, considerably higher than expected emissions. Therefore, toxic effects to wildlife from HF emissions would be expected to be negligible.

A portion of the U_3O_8 released from the process stack of a conversion facility would become deposited on the soils surrounding the site. Uptake of uranium-containing compounds can cause adverse effects to vegetation. Deposition of U_3O_8 on soils, resulting from atmospheric emissions, would result in soil uranium concentrations considerably below the lowest concentration known to produce toxic effects in plants. Therefore, toxic effects on vegetation due to U_3O_8 uptake would be expected to be negligible.

Effluent discharges to surface waters would result in a uranium concentration of about 12 pCi/L (0.03 mg/L) as uranyl nitrate (Section 5.3.4.1). Resulting dose rates to maximally exposed organisms would be considerably lower than the dose limit of 1 rad/d for aquatic organisms, which is required by DOE Order 5400.5. Uranyl nitrate concentrations in the effluent also would be considerably lower than 0.15 mg/L, the lowest concentration known to cause toxic effects in aquatic biota. Mixing of the effluent with surface water downstream of the outfall would result in a dilution factor of about 48,000. Therefore, impacts to aquatic biota would be considered to be negligible.

For the U_3O_8 conversion process, water withdrawal from surface waters or groundwater, as well as wastewater discharge, could potentially alter water levels which could in turn affect aquatic ecosystems including wetlands (including wetlands located along the periphery of these surface water bodies). However, water level changes due to process water withdrawal and wastewater discharge would be negligible (Section 5.3.4.1). Therefore, impacts to wetlands would be expected to be negligible.

A potential release of contaminants due to the occurrence of an earthquake was analyzed. The subsequent rupture of an HF pipeline would potentially release anhydrous HF into the surrounding soil, surface water, or groundwater. Due to the brief duration of the release, the small volume involved, and rapid mitigation, the expected impacts to surface water, groundwater, and soil would be negligible (Section 5.3.4). Therefore, impacts to ecological resources from such an accident would also be expected to be negligible. Facility accidents could result in adverse impacts to ecological resources. The affected species and the degree of impact would depend on a number of factors such as location of the accident, season, and meteorological conditions.

5.3.6.2 Conversion to UO_2

The construction of a facility to convert depleted UF_6 to UO_2 would generally result in the types of impacts associated with conversion to U_3O_8. Site preparation for the construction of a facility to convert depleted UF_6 to UO_2 would require the disturbance of approximately 22 to 31 acres (8.9 to 12.5 ha), including the permanent replacement of approximately 14 to 19 acres (5.5 to 7.8 ha) with structures and paved areas. The loss of 22 to 31 acres (8.9 to 12.5 ha) of undeveloped land would constitute a moderate adverse impact to vegetation. The permanent loss of up to 19 acres (7.8 ha) of habitat would not be expected to threaten the local population of any wildlife species because similar habitat would be available in the vicinity of the site. However, habitat use in the vicinity of the facility might be greatly reduced for many species due to the construction of a perimeter fence. Consequently, the construction of a conversion facility for UO_2 production is considered a moderate adverse impact to wildlife.

Impacts to surface water and groundwater quality during construction would be expected to be negligible (Section 5.3.4). Thus, construction-derived impacts to aquatic biota would also be expected to be negligible. Impacts to wetlands and protected species due to facility construction would be similar to impacts associated with conversion to U_3O_8.

During operations, exposures to contaminants from conversion to UO_2 would generally be slightly larger than for conversion to U_3O_8, but all exposures would be well below levels that might produce adverse effects. All impacts would therefore be negligible. Impacts to ecological resources from accident scenarios would be as discussed for conversion to U_3O_8 (Section 5.3.6.1).

5.3.6.3 Conversion to Metal

Construction of a facility to convert depleted UF_6 to uranium metal would generally result in the types of impacts associated with conversion to U_3O_8. Site preparation would require the disturbance of approximately 23 to 26 acres (9.4 to 11 ha), including the permanent replacement of about 15 to 16 acres (6.2 to 6.5 ha) with structures and paved areas. The loss of 23 to 26 acres (9.4 to 11 ha) of undeveloped land would constitute a moderate adverse impact to vegetation and wildlife. Impacts due to facility construction are shown in Table 5.24.

During operation of the metal conversion facility, exposure to contaminants would be considerably below levels known to cause toxic effects in biota. The resulting impacts would therefore be negligible. Impacts to ecological resources from accidents would be as discussed for conversion to U_3O_8 (Section 5.3.6.1).

Construction of a cylinder treatment facility would generally result in the types of impacts associated with construction of a conversion facility; however, the area affected would be smaller

(Table 5.24). Site preparation for constructing a cylinder treatment facility would require the disturbance of approximately 9 acres (4 ha). About 5 acres (2 ha) would be permanently replaced with structures, paved areas, and landscaping. The loss of 9 acres (4 ha) of undeveloped land would constitute a moderate adverse impact to vegetation and wildlife. Exposure to contaminants resulting from operation of a cylinder treatment facility would be considerably below levels known to result in toxic effects to biota. The resulting impacts would therefore be negligible.

5.3.7 Waste Management

Impacts on waste management from wastes generated during construction and normal operations at the depleted UF_6 conversion facilities would be caused by the potential overload of waste treatment and/or disposal capabilities either at the site or on a regional/national scale. The types of wastes that are expected to be generated by the depleted UF_6 conversion include LLW, LLMW, hazardous waste, nonhazardous solid waste, and nonhazardous wastewater. Currently, there are numerous DOE and commercial facilities that treat and/or dispose of LLW, hazardous waste, nonhazardous solid waste, and wastewater. The treatment/disposal of LLMW is limited by regulatory and technological restrictions.

5.3.7.1 Conversion to U_3O_8

Construction of a facility at the Portsmouth site to convert UF_6 into U_3O_8 would generate both hazardous and nonhazardous wastes. Approximately 115 m^3 of hazardous waste, 700 m^3 of nonhazardous solid waste, and 15,000 m^3 of wastewater would be generated during construction (see Table 5.25). This compares with an existing contribution for hazardous waste of approximately 120 m^3/yr, and wastewater loads of 500,000 m^3 annually at the Portsmouth site (see Section 2.9). Solid waste loads for the Portsmouth site were unreported (DOE 1996a). No radioactive waste would be generated during the construction phase of the facility. Overall, only minimal waste management impacts would result from construction-generated wastes.

Operations at the facility to convert UF_6 into U_3O_8 would generate radioactive, hazardous, and nonhazardous wastes (Table 5.25). The conversion facility would generate 140 to 600 m^3/yr of LLW, which, at the upper end, represents approximately 12% of the Portsmouth site annual LLW load. The U_3O_8 conversion facility waste input would represent less than 1% of DOE LLW generation. The U_3O_8 conversion facility would generate approximately 1.1 m^3/yr of LLMW, which is less than 1% of the LLMW generation at the site. The U_3O_8 conversion facility would generate approximately 7 m^3/yr of hazardous waste, which would result in an increase of about 6% of the hazardous waste load at the site and about 60,000 to 90,000 m^3/yr of wastewater, representing between 12 and 18% of the current loads for wastewater at the site.

TABLE 5.25 Wastes Generated from Construction and Operations Activities for Depleted UF_6 Conversion

Activity/ Waste Category	Volume Ranges for the Options		
	Conversion to U_3O_8	Conversion to UO_2	Conversion to Metal
Construction (m^3)[a]			
Low-level waste	–	–	–
Low-level mixed waste	–	–	–
Hazardous waste	115	140 – 200	140 – 180
Nonhazardous waste			
Solids	700	1,300	860 – 1,130
Wastewater	3,800	7,600	5,700 – 7,580
Sanitary wastewater	11,400	17,000	13,200 – 15,200
Operations (m^3/yr)			
Low-level waste			
Combustible waste	76.5	88.0 – 136	76.5 – 420
Noncombustible	62 – 68.2	82.0 – 140	112 – 470
Grouted	0 – 466	0 – 466	0 – 997
Total	140 – 600	170 – 740	190 – 1,890
Low-level mixed waste	1.1	1.1 – 8.8	1.1
Hazardous waste	7.32	7.32 – 17	7.32 – 9.5
Nonhazardous waste			
Solids	380 – 11,000[b]	520 – 30,600[b]	6,580 – 6,840[c]
Wastewater	58,000 – 87,100	74,900 – 510,000	94,000 – 96,500
Sanitary wastewater	4,540 – 4,920	5,680 – 8,700	5,300 – 8,700

[a] Total waste generated during construction period of 4 years.

[b] Includes 240 to 10,630 m^3 of CaF_2.

[c] Includes 67 m^3 of CaF_2 and 5,850 to 6,110 m^3 of MgF_2.

The CaF_2 potentially produced in the U_3O_8 conversion process was assumed to have a uranium content of less than 1 ppm (LLNL 1997). It is currently unknown whether this CaF_2 could be sold (e.g., as feedstock for commercial production of anhydrous HF) or whether the low uranium content would require disposal as either a nonhazardous solid waste or as LLW. The nonhazardous solid waste generation estimates for conversion to U_3O_8 and UO_2, as shown in Table 5.25, are based on the assumption that CaF_2 would be disposed of as nonhazardous solid waste, generating approximately 240 to 11,000 m^3/yr of nonhazardous solid waste. (This could represent a significant addition to the nonhazardous solid waste load at the site, depending on the conversion technology chosen.) If CaF_2 was considered to be LLW, it would represent an additional 5 to 220% of the current LLW load. The upper end of the range of nonhazardous and LLW volume increases (which correspond to the HF neutralization process) would constitute a potentially large impact to either nonhazardous or LLW management activities at the site. Disposal as LLW might require the CaF_2 to be grouted, generating up to 21,300 m^3/yr of grouted waste. The maximum volume of LLW generated would still represent less than 10.4% of the projected DOE complexwide LLW disposal volume, constituting a moderate impact with respect to complexwide LLW management. It is also unknown whether CaF_2 LLW would be considered DOE waste if the conversion were conducted by a private commercial enterprise. If CaF_2 could be sold, the nonhazardous solid waste or LLW management impacts would be reduced to a low level for U_3O_8 conversion technologies.

The impacts from normal operation of the U_3O_8 conversion facility would range from negligible to large, depending upon the choice of technology and the ultimate generation volumes and disposition of CaF_2 for the facility. Overall, the waste input resulting from normal operations at the U_3O_8 conversion facility would be expected to have a moderate impact on waste management. If CaF_2 were disposed of as nonhazardous solid waste, the increased input could be managed by expanding the capacity of the nonhazardous solid waste disposal facilities at the site.

5.3.7.2 Conversion to UO_2

Construction of a facility to convert UF_6 into UO_2 would generate approximately the same quantity of hazardous wastes as conversion to U_3O_8. Construction would generate approximately 1,300 m^3 of solid nonhazardous wastes and up to 24,000 m^3 of wastewater (see Table 5.25). These waste loads are well below the expected Portsmouth site waste inputs for comparable nonhazardous wastes and moderately lower than the expected hazardous waste load. No radioactive waste would be generated during the construction phase of the facility. Overall, only minimal waste management impacts would result from construction-generated wastes.

Operations at the facility to convert UF_6 into UO_2 would generate radioactive, hazardous, and nonhazardous wastes (Table 5.25). The conversion facility would generate about 4 to 15% of the site LLW load. The UO_2 conversion facility would generate up to 465 m^3/yr of a solid, grouted LLW that would require off-site disposal. The conversion facility LLW input would represent less than 1% of the projected annual DOE LLW treatment volume. The UO_2 conversion facility would generate less than 1% of the LLMW generation for the site. The UO_2 conversion facility would generate 7 to 17 m^3/yr of hazardous waste, which represents a 6 to 14% increase to the hazardous waste load from routine operations. The UO_2 conversion facility would add 520 to 30,600 m^3/yr of nonhazardous solid waste, which could be a significant increase to the unreported nonhazardous solid waste load at the Portsmouth site. The expected 80,000 to 500,000 m^3/yr of wastewater represents a 16 to 100% addition to the current site wastewater load.

As in the U_3O_8 conversion option, it is currently unknown whether CaF_2 generated in the conversion to UO_2 option could be sold or whether the low uranium content (less than 1 ppm) would require disposal as either a nonhazardous solid waste or as LLW. The nonhazardous solid waste generation estimates for conversion to UO_2 shown in Table 5.25 are based on the assumption that CaF_2 would be disposed of as nonhazardous solid waste, generating about 240 to 11,000 m^3/yr of nonhazardous solid waste (a significant addition to the current nonhazardous solid waste load at the site, depending on the conversion technology chosen). If CaF_2 was considered to be LLW, it would represent up to 230% of the current LLW loads at the site. The upper end of the range of nonhazardous and LLW volume increases (which correspond to the HF neutralization process) would constitute a potentially large impact to either nonhazardous or LLW management activities at the Portsmouth site. Disposal as a LLW might require the CaF_2 to be grouted, generating up to 21,300 m^3/yr of grouted waste. However, the maximum volume of LLW generated would still represent less than 10.4% of the projected DOE complexwide LLW disposal volume, constituting a moderate impact with respect to complexwide LLW management, if the CAF_2 were considered DOE waste. If CaF_2 could be sold, the nonhazardous solid waste or LLW management impacts would be reduced to a low level for UO_2 conversion technologies.

The large range in the expected volume of nonhazardous solid waste and wastewater is also a result of differences in UO_2 conversion technologies. The gelation technology would result in the highest nonhazardous waste generation volumes. The range of 520 to 30,600 m^3/yr for nonhazardous solid wastes may represent a significant increase to the annual nonhazardous solid waste production at the site. The estimated range for wastewater generation represents a range of about 16 to 100% of the annual wastewater generation at the representative sites.

The impacts from normal operation of the UO_2 conversion facility would range from negligible to large, depending upon the choice of technology for this facility. Overall, the waste input resulting from normal operations at the UO_2 conversion facility would be expected to have a moderate impact on waste management. The increased solid waste input could be managed by expanding the capacity of the solid nonhazardous waste disposal facilities at the sites. The increased wastewater input would be handled by existing site wastewater capabilities of the Portsmouth site.

5.3.7.3 Conversion to Metal

Construction of a facility at the Portsmouth site to convert UF_6 into uranium metal would generate approximately the same quantity of hazardous and nonhazardous wastes as conversion to U_3O_8 or UO_2 (Table 5.25). No radioactive waste would be generated during the construction phase of the facility. Overall, only minimal waste management impacts would result from construction-generated wastes.

Operations at the facility to convert UF_6 into uranium metal would generate radioactive, hazardous, and nonhazardous wastes (Table 5.25). The conversion facility would generate about 24 to 40% of the site LLW load. A metal conversion facility LLW input would represent less than 3% of the projected annual DOE LLW treatment volume. The metal conversion facility would generate less than 1% of the LLMW generation at the site and less than 8% of the hazardous waste load from routine operations at the site. The metal conversion facility could add a significant amount of waste to the existing site solid waste load and 21% to the load for wastewater. The increased solid waste input could be managed by expanding the disposal capacity of the solid nonhazardous waste disposal facilities at the Portsmouth site.

It is possible that the MgF_2 waste generated in the conversion to metal option would be sufficiently contaminated with uranium to require disposal as LLW rather than as solid nonhazardous waste. The uranium level in the MgF_2 is estimated to be about 90 ppm (LLNL 1997). Such disposal might require the MgF_2 waste to be grouted, generating about 6,150 to 12,300 m^3/yr of grouted waste for LLW disposal. This volume range represents about 130 to 260% of the current LLW generation for the site. However, it would represent less than 6% of the projected DOE complexwide LLW disposal volume, constituting a low impact with respect to complexwide LLW management, if the MgF_2 was considered a DOE waste.

Neutralization of HF to CaF_2 was not explicitly analyzed in the engineering analysis report for the conversion to metal options (LLNL 1997). However, the process could be implemented and would produce approximately one-third as much CaF_2 as would be produced under the conversion to oxide with neutralization options (i.e., approximately 3,500 m^3/yr of CaF_2). If this CaF_2 waste was disposed of as LLW, it would constitute less than 3% of the DOE complexwide LLW disposal volume, representing a low impact with respect to complexwide LLW management.

Overall, the waste input resulting from normal operations at the uranium metal conversion facility would have a moderate impact on waste management.

5.3.7.4 Cylinder Treatment Facility

All of the conversion options would require the removal of depleted UF_6 from the storage cylinders, resulting in a large number of empty cylinders. These empty UF_6 cylinders from the conversion facility would be decontaminated at the cylinder treatment facility and then are assumed to be added to the DOE-scrap metal inventory. It was assumed for this assessment that the cylinder treatment facility would be washing the empty cylinders with water to remove the "heels" of depleted UF_6. The resulting aqueous wash solution would be evaporated and converted to solid U_3O_8 and HF. The U_3O_8 would be packaged and sent for disposal. The HF would be neutralized to CaF_2 and separately packaged for either disposal or sale.

Construction of the cylinder treatment facility would generate both hazardous and nonhazardous wastes. These waste quantities — hazardous, 18 m^3; solid nonhazardous, 300 m^3; and sanitary and other nonhazardous liquids, 28,000 m^3 — all represent only minimal waste management impacts for the Portsmouth site. No radioactive waste would be generated during construction of this facility.

The amounts of waste generated annually during operation of the cylinder treatment facility are given in Table 5.26. Included are crushed old cylinders and wastes obtained (U_3O_8 and CaF_2) from disposal of the "heels." All of these wastes, except the crushed old cylinders, represent only negligible impacts to the waste management system. Over 20 years of operations, the crushed old cylinders (2,322 cylinders/yr) would generate about 125,000 m^3 (6,190 m^3/yr × 20 years) of waste volume for disposal. It was assumed that the treated cylinders with a very low residual radiation level would become part of the DOE scrap metal inventory. If a disposal decision were made, the treated cylinders would be disposed of as LLW, representing a 3% addition to the projected DOE complexwide LLW disposal volume.

TABLE 5.26 Annual Waste Generation during Operation of the Cylinder Treatment Facility

Waste Category	Volume (m^3/yr)
Low-level waste	
Combustible solids	31
Contaminated metal and other noncombustible solids	11
U_3O_8	6.3
Low-level mixed waste	0.2
Hazardous waste	2
Nonhazardous waste	
Solids	100
Wastewater	6,400
CaF_2	14
Sanitary waste	2,300
Crushed cylinders	6,190

5.3.7.5 Summary

The impacts from the uranium metal conversion facility would be greater than the waste management impacts resulting from operations of U_3O_8 conversion, unless CaF_2 required disposal as a waste. In the latter case, the impacts to waste management facilities for U_3O_8 conversion would probably exceed those for uranium metal conversion. The largest waste volumes would result from conversion to UO_2.

5.3.8 Resource Requirements

The approach taken for assessment of resource requirements was based on a comparison of required resources with national and state-level statistics on consumption of commodities (U.S. Department of Commerce 1997, 1999). More detailed information related to the methodology is presented in Appendix C of the PEIS.

Utilities and materials required for constructing the conversion facility for UF_6 to U_3O_8, UO_2, or uranium metal are listed in Table 5.27. The equipment for conversion processes would be purchased from equipment vendors. The total quantities of commonly used materials of construction (e.g, carbon steel, stainless steel) for equipment would be minor compared to the quantities required for facility construction, as listed in Table 5.27. The primary specialty materials required for fabricating process equipment include Monel and Inconel (LLNL 1997). Utilities and materials required for operating the three types of conversion facilities are shown in Table 5.28.

5.3.9 Land Use

5.3.9.1 Conversion to U_3O_8

Impacts to land use from the construction and operation of a U_3O_8 conversion facility at the Portsmouth site would generally be negligible. Such impacts would be limited to the clearing of required land, minor and temporary disruptions to contiguous land parcels, and a slight increase in vehicular traffic. Under this conversion option, a conversion facility would require approximately 20 acres (8 ha) for construction and about 13 acres (5 ha) for operation (see Table 5.29). The construction phase requires more land because space is needed for material excavation storage, equipment staging, and construction material laydown areas. These land areas constitute less than 1% of the land area of the Portsmouth site.

TABLE 5.27 Resource Requirements for Constructing a Conversion Facility

Utilities/Materials	Total Consumption: Conversion to U_3O_8	Conversion to UO_2	Conversion to Metal
Utilities			
Electricity[a] (MWh)	30,000	35,000	35,000 – 45,000
Solids			
Concrete (yd^3)	15,000 – 18,000	21,000 – 44,300	20,000 – 23,000
Steel (carbon or mild) (tons)	6,000 – 7,000	8,000 – 8,800	9,000 – 10,000
Liquids (million gal)			
Diesel fuel	0.75	0.45 – 0.80	0.80 – 1.0
Gasoline	0.75	0.40 – 0.80	0.80 – 1.0
Gases (gal)			
Industrial gases (propane)	4,000	4,400	4,400 – 5,500
Specialty materials (tons)			
Monel	15 – 30	25 – 88	20 – 100
Inconel	10	10 – 88	0 – 4
Titanium	NA[b]	0 – 33	0 – 10

[a] The peak electricity demand during any hour would be as follows: conversion to U_3O_8, about 1.5 MW; conversion to UO_2, about 1.5 MW; conversion to metal, from 1.5 to 2.5 MW.

[b] NA = not applicable.

Source: LLNL (1997).

The amount of land required for this conversion option would not be great enough to require major land modification. However, it should be noted that siting a conversion facility at a location within the site that has been previously disturbed or used industrially could result in fewer land-use impacts because immediate access to infrastructure and utility support would be possible with only minor disturbances to existing land use.

Impacts to land use outside the boundaries of a conversion facility would include negligible and temporary traffic impacts associated with project construction peaks. Also, because of the handling of UF_6 at the facility, NUREG-1140 (McGuire 1985) suggests that a 1-mile protective action distance be established around such a facility, which would cover an area of about 960 acres.

TABLE 5.28 Resource Requirements for Operating a Conversion Facility

	Average Annual Requirement		
Utilities/Materials	Conversion to U_3O_8	Conversion to UO_2	Conversion to Metal
Utilities			
Electricity[a] (GWh)	11.0	24 – 29	25 – 44
Liquid fuel (gal)	6,000	3,040 – 7,000	6,500 – 9,500
Natural gas (million scf)[b]	102 – 118	38 – 116	100 – 167
Solids			
Calcium hydroxide (hydrated lime) (million lb)	0.388 – 1.27	0.388 – 1.27	0.247
Calcium oxide (quicklime) (million lb)	0 – 29	0 – 29	NA[c]
Cement (lb)	0 – 862,000	0 – 862,000	0 – 940,000
Detergent (lb)	500	600	600 – 700
Iron (million lb)	NA	NA	0 – 1.3
Magnesium (million lb)	NA	NA	8.4 – 8.6
Sodium chloride (lb)	NA	NA	0 – 514,000
Pelletizing lubricant (lb)	NA	236,000	NA
Liquids			
Ammonia (million lb)	0 – 0.662	2.9	2.4
Hydrochloric acid (lb)	11,100 – 18,200	8,900 – 13,600	5,300 – 9,500
Nitric acid (lb)	NA	NA	0 – 230,000
Sodium hydroxide (lb)	8,800 – 14,400	7,000 – 10,700	4,200 – 7,500

[a] Peak electricity demand during any hour would be as follows: conversion to U_3O_8, about 1.5 MW; conversion to UO_2, from 3.2 to 4.0 MW; conversion to metal, from 3.3 to 6.0 MW.

[b] scf = standard cubic feet measured at 14.7 lb/in.^{2} absolute (psia) and 60EF.

[c] NA = not applicable.

Source: LLNL (1997).

The protective action distance is the recommended distance for which emergency planning would be appropriate to mitigate off-site exposure to accidental releases.

5.3.9.2 Conversion to UO_2

Impacts to land use from the UO_2 conversion option would be slightly greater than those associated with other conversion options. The areal requirements for this option range from 22 to

TABLE 5.29 Land Requirements for the Conversion Options

	Land Requirement (acres)[a]	
Option	Construction	Operation
Conversion to U_3O_8	20	13
Conversion UO_2	22 – 31	14 – 20
Conversion to metal	23 – 26	15 – 16

[a] NUREG-1140 (McGuire 1985) suggests that each conversion facility establish a protective action distance for emergency planning, which would incorporate an area of about 960 acres around each facility.

Source: LLNL (1997).

31 acres (9 to 13 ha) for construction and from 14 to 20 acres (5.5 to 8 ha) for operations (Table 5.29), still less than 1% of the land area of the Portsmouth site. Siting a conversion facility at a location within the site that has been previously disturbed or used industrially could result in fewer land-use impacts because immediate access to infrastructure and utility support would be possible with only minor disturbances to existing land use.

Impacts to local traffic patterns outside potential UO_2 conversion plant sites could be greater than those expected under the conversion to U_3O_8 option due to the potential for increased traffic volume associated with greater construction workforce demands. However, such impacts would be temporary and would be expected to diminish during the operations phase. The protective action distance described in Section 5.3.9.1 would be applicable to an area of about 960 acres around the facility.

5.3.9.3 Conversion to Metal

Land-use impacts at the Portsmouth site from the conversion to uranium metal option would be minimal. Land requirements (Table 5.29) would be similar to those discussed for the conversion to UO_2 option, and impacts related to construction traffic outside the conversion plant sites would be negligible. The protective action distance would be applicable to an area of about 960 acres around the facility.

5.3.9.4 Cylinder Treatment Facility

Impacts to land use from the construction and operation of a cylinder treatment facility would be negligible and of a lesser magnitude than those generated under any of the conversion options. Although the cylinder treatment facility could be a stand-alone facility, it is likely to be integrated into a depleted UF_6 conversion facility. If the cylinder treatment facility were incorporated into a conversion facility, it would require less than 1 acre (0.4 ha) of additional land, regardless of the conversion option.

As a stand-alone facility, the cylinder treatment facility would require 9.7 acres (3.5 ha) of land for construction and about 5 acres (2 ha) for operations. The areal requirement would not be large enough to result in any but minor land-use impacts, particularly if the facility was sited at a location already dedicated to a similar industrial-type use.

5.3.10 Other Impacts Considered But Not Analyzed in Detail

Other impacts that could potentially occur if the conversion options considered in this PEIS were implemented include impacts to cultural resources and environmental justice, as well as impacts to the visual environment (e.g., aesthetics), recreational resources, and noise levels, and impacts associated with decontamination and decommissioning of the conversion facilities. These impacts, although considered, were not analyzed in detail for one or both of the following reasons:

- The impacts (e.g., impacts on cultural resources, threatened and endangered species, wetlands, and environmental justice) could not be determined at the programmatic level without considering specific locations for construction within the Portsmouth site, which are not currently known. These impacts would be more appropriately addressed in the second-tier NEPA documentation when specific locations are considered.

- Consideration of these impacts would not contribute to differentiation among the alternatives and, therefore, would not affect the decisions to be made in the ROD for the PEIS.

5.4 POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED WITH CONVERSION OF THE ENTIRE CYLINDER INVENTORY AT THE PORTSMOUTH SITE

After the draft PEIS was completed, management responsibility for approximately 11,200 additional cylinders of depleted UF_6 was transferred from USEC to DOE by the signing of two

MOAs associated with the privatization of USEC (DOE and USEC 1998a,b). To account for uncertainties associated with the number of cylinders that would be transferred from USEC to DOE in the future and to provide a bounding analysis of environmental impacts, the final PEIS evaluated the environmental impacts of managing an additional 15,000 cylinders. These analyses are summarized in Chapter 6 of the PEIS; impacts associated with conversion of the entire inventory (including USEC cylinders) at the Portsmouth site are summarized here in Section 5.4.2.

5.4.1 Approach Used to Evaluate the Environmental Impacts of Conversion for the Entire Cylinder Inventory

To account for the additional USEC-generated cylinders in the conversion options, the basic facility designs were assumed to remain the same, but the facilities were assumed to operate over a longer period of time. It was assumed that the period for operations would be extended by about 6 years to accommodate the additional USEC-generated cylinders (i.e., from 20 to 26 years). Under this assumption, annual impacts would generally remain the same as those reported on in Section 5.3, although the total impacts would generally increase by about 30%.

5.4.2 Potential Environmental Impacts from Conversion of the Entire Cylinder Inventory (DOE- and USEC-Generated Cylinders)

5.4.2.1 Human Health and Safety — Normal Operations

5.4.2.1.1 Workers

In general, the average annual radiation dose to individual workers associated with conversion of the additional USEC cylinders would be the same as that for DOE-generated cylinders reported on in Section 5.3.1 (i.e., well within applicable standards) because at conversion facilities, the annual worker activities would be the same, but the facilities would operate over a longer period of time. The total doses and numbers of LCFs for involved and noninvolved workers would be increased by about 30% (see values in brackets in Table 5.2).

Hazard indices for exposure to chemicals would not change from those presented in Table 5.6 (maximum of 1.2×10^{-6} for noninvolved workers), because annual emissions would not change.

5.4.2.1.2 General Public

For conversion options, the annual dose to the general public MEI reported in Table 5.2 would not change with the addition of the USEC cylinders. The total collective dose to the general public would increase by about 30% (see values in brackets in Table 5.2).

No chemical impacts to the general public would be associated with the increased cylinder inventory. The estimated maximum hazard index for the general public MEI of 0.0001 given in Table 5.6 would not change; this level is far below the threshold level for adverse effects.

5.4.2.2 Health and Human Safety — Accident Conditions

5.4.2.2.1 Physical Hazards

The total number of worker fatalities and injuries associated with conversion options would increase by about 30% with the addition of the USEC cylinders (see values in brackets in Table 5.2).

5.4.2.2.2 Accidents Involving Releases of Radiation or Chemicals

For accident consequences, impacts would be the same as those previously discussed for the DOE-generated cylinders (Section 5.3.2), because the types of accidents assessed would involve only a limited amount of material that would be at risk under accident conditions. Although the estimated frequencies of some accidents would increase somewhat in association with the additional USEC-generated cylinders, this increase is not expected to be enough to change the overall expected frequency of specific accidents from the broad ranges used in the PEIS.

5.4.2.3 Air Quality

At oxide or metal conversion facilities, annual criteria pollutant emissions from construction and operation would be identical to those discussed for DOE-generated cylinders in Section 5.3.3, because conversion facilities would not increase in size, only in duration of operations. For oxide conversion options, an additional 12 to 66 lb (5 to 30 kg) of uranium (as U_3O_8 or UO_2) would be emitted during 6 additional years of operations. For metal conversion options, an additional 24 to 66 lb (11 to 30 kg) of uranium (as U_3O_8 or UF_4) would be emitted during 6 additional years of operations. The total uranium emissions that would result from conversion of both the DOE- and USEC-generated inventory could range from about 52 to 290 lb (24 to 132 kg) for oxide conversion options and from about 100 to 290 lb (45 to 130 kg) for metal conversion options. No air quality standards exist for uranium compounds. However, the potential health impacts from these emissions were evaluated in Section 5.4.2.1.

5.4.2.4 Water and Soil

The amount of water used to construct conversion facilities would be the same as discussed for DOE-generated cylinders in Section 5.3.4. The duration of operational activities at conversion facilities would increase by 6 years, resulting in an additional water requirement of about 200 to 1,700 million gal for oxide conversion options and about 330 million gal for metal conversion options. About 90–840 million gal and 150–180 million gal of additional wastewater would be generated for the oxide and metal conversion options, respectively. The total water requirements would range from about 880 to 7,400 million gal for oxide conversion and be about 1,400 million gal for metal conversion; the total wastewater generated would range from about 390 to 3,600 million gal for oxide conversion and 650 to 780 million gal for metal conversion.

Impacts to surface water and groundwater from conversion facilities would partially depend on the actual location within the Portsmouth site. On the basis of the assessment in Section 5.3.4, impacts from the DOE cylinders only were expected to be negligible. Additional impacts to surface water, groundwater, or soil as a result of conversion of the additional USEC-generated cylinders would also be negligible because annual emissions would not change.

5.4.2.5 Socioeconomics

The annual socioeconomic impacts from operating a conversion facility would be the same as those estimated for the DOE-generated cylinders in Section 5.3.5, but the period of operation would be extended by 6 years. Annual socioeconomic impacts during construction would also be the same as those for managing DOE-generated cylinders.

5.4.2.6 Ecology

At a conversion facility, the processing of USEC-generated cylinders would not result in any additional land use requirements or habitat loss, because the size of the conversion facility would not change. Impacts would remain as discussed in Section 5.3.6.

5.4.2.7 Waste Management

The duration of operational activities at a U_3O_8 conversion facility would be increased by 6 years, resulting in the generation of about 1,100 to 4,700 yd^3 (840 to 3,600 m^3) of additional LLW, 8 yd^3 (6 m^3) of additional LLMW, and 55 yd^3 (42 m^3) of additional hazardous waste. For conversion to UO_2, about 1,300 to 5,800 yd^3 (1,000 to 4,400 m^3) of additional LLW, 0 to 1,400 yd^3 (0 to 1,100 m^3) of additional LLMW, and 55 to 130 yd^3 (42 to 100 m^3) of additional hazardous waste would be generated. The construction impacts would be the same as those presented for DOE-generated cylinders in Section 5.3.7. For conversion to U_3O_8, the total waste generated during operations (USEC- and DOE-generated material) would be about 4,700 to 21,000 yd^3 (3,600 to 16,000 m^3) of LLW, 34 yd^3 (26 m^3) of LLMW, and 240 yd^3 (180 m^3) of hazardous waste. For conversion to UO_2, the total waste generated during operations (USEC- and DOE-generated material) would be about 5,800 to 25,000 yd^3 (4,400 to 19,000 m^3) of LLW, 0 to 620 yd^3 (0 to 470 m^3) of LLMW, and 240 to 580 yd^3 (180 to 440 m^3) of hazardous waste. (The ranges are the result of assessing different conversion technologies.)

If CaF_2 was produced in the conversion-to-oxide process, and if the CaF_2 was disposed of as nonradioactive, nonhazardous solid waste, an additional 3,000 to 87,000 yd^3 (2,300 to 66,000 m^3) of nonradioactive, nonhazardous solid waste would be generated over the additional 6 years of operation. The capacity for managing this annual volume of nonhazardous waste would already be in place. If the CaF_2 was disposed of as LLW, an additional 170,000 yd^3 (128,000 m^3) of LLW would be generated over the additional 6 years of operation. (The additional volume would be the result of grouting.) In total, about 720,000 yd^3 (550,000 m^3) of CaF_2 LLW could be generated as a result of conversion to oxide. This quantity would represent about 13% of the projected DOE complexwide disposal volume for approximately the same time period, an amount that would represent a moderate impact on waste management if the LLW was considered to be DOE waste.

At a metal conversion facility, the impacts during construction would be the same as those for DOE-generated cylinders described in Section 5.5.7. Operation of the metal conversion facility would increase by 6 years, so about 1,400 to 14,000 yd^3 (1,100 to 11,000 m^3) of additional LLW, 8 yd^3 (6 m^3) of additional LLMW, and 55 to 78 yd^3 (42 to 60 m^3) of additional hazardous waste would be generated as a result of including the USEC-generated cylinders. The total waste generated during operations for conversion of both DOE- and USEC-generated cylinders would be about 6,400 to 64,000 yd^3 (4,900 to 49,000 m^3) of LLW, 34 yd^3 (26 m^3) of LLMW, and 230 to 340 yd^3 (180 to 260 m^3) of hazardous waste. (The ranges are the result of assessing different conversion technologies.)

If MgF_2 produced in the metal conversion process was disposed of as nonradioactive, nonhazardous solid waste, an additional 48,000 yd^3 (37,000 m^3) of nonradioactive, nonhazardous solid waste would be generated. This additional waste would be disposed of annually (about 7,900 yd^3 [6,100 m^3] per year) over the additional 6 years of operation of the conversion facility. The capacity for managing this annual volume of nonhazardous waste would already be in place. If the MgF_2 needed to be disposed of as LLW, an additional 96,000 yd^3 (74,000 m^3) of LLW would be generated over the additional 6 years of operation. This additional volume would be a result of grouting. In total, about 420,000 yd^3 (320,000 m^3) of MgF_2 LLW could be generated through conversion to metal. This amount of LLW would represent less than 8% of the projected DOE complexwide disposal volume for approximately the same time period, which would be considered a low impact for waste management if the LLW was considered DOE waste. If HF was neutralized to produce CaF_2, and if the CaF_2 needed to be disposed of as LLW, an additional 27,000 yd^3 (21,000 m^3) of CaF_2 would be produced, yielding a total of 120,000 yd^3 (91,000 m^3) of grouted CaF_2 LLW. This additional volume of LLW would constitute approximately 4% of the projected DOE complexwide LLW disposal volume.

The duration of operational activities at a cylinder treatment facility would increase by 6 years, resulting in a total of about 380 yd^3 (290 m^3) of additional LLW, 1.6 yd^3 (1.2 m^3) of additional LLMW, and 16 yd^3 (12 m^3) of additional hazardous waste generated as a result of the inclusion of the USEC-generated cylinders. The construction impacts would be the same as those described for management of DOE-generated material. The total waste generated during treatment operations for both DOE- and USEC-generated cylinders would be about 1,600 yd^3 (1,200 m^3) of LLW, 6.8 yd^3 (5.2 m^3) of LLMW, and 68 m^3 (52 m^3) of hazardous waste. The crushed cylinders, totaling about 37,000 m^3, would add an additional 1% to the projected DOE complexwide LLW disposal volume (if a decision for disposal was made). The total inventory of crushed cylinders would add an additional 4% to the projected DOE complexwide LLW disposal volume.

5.4.2.8 Resource Requirements

In general, the addition of the USEC cylinders would not change the impact assessment for resource requirements for conversion activities. The construction requirements identified in Section 5.3.8 would remain the same. The annual resource requirements identified in Table 5.28 would be extended for an additional 6 years. No significant impacts would be expected, because construction and operational requirements would not be resource intensive, and the resources required would not be rare or unique.

5.4.2.9 Land Use

The land use required for conversion facilities would be the same as that for management of DOE-generated cylinders only described in Section 5.3.9, because the facility sizes would remain the same.

5.4.2.10 Cultural Resources

Impacts to cultural resources from a conversion facility at the Portsmouth site cannot be determined at this time and would depend on the exact location within the site and whether eligible cultural resources existed on or near that location.

5.4.2.11 Environmental Justice

Potential environmental justice impacts to minority and low-income populations from the construction and operation of conversion facilities would depend on the locations of these facilities within the Portsmouth site. Although these specific locations are not known, no disproportionately high and adverse effects to minority or low-income populations would be expected in the vicinity of the Portsmouth site in association with the conversion for the entire cylinder inventory (DOE- and USEC-generated cylinders), because impacts from conversion activities did not exceed the screening criteria for adverse impacts outlined in Section C.8.2.3 of the depleted UF_6 PEIS.

6 ENVIRONMENTAL IMPACTS OF OPTIONS FOR LONG-TERM STORAGE AS UF_6 OR URANIUM OXIDE AT THE PORTSMOUTH SITE

Storage Options

Depleted uranium could be stored until use at a later date. Storage options are defined by the chemical form of the uranium and the type of storage facility. The following storage options are considered in the PEIS:

Storage as UF_6. Storage of UF_6 could take place in cylinders similar to those currently used. Storage facilities considered include yards and buildings.

Storage as U_3O_8. Depleted uranium could be stored in drums as U_3O_8 following conversion. Storage facilities considered for U_3O_8 include buildings and belowground vaults.

Storage as UO_2. Similar to options for U_3O_8, depleted uranium could be stored in drums as UO_2 in buildings or belowground vaults.

Storage of the depleted uranium is defined as holding the material for a temporary period, after which it is either converted to another chemical form, used, disposed of, or stored elsewhere. Storage options would preserve access to the depleted uranium for use at a later date by storing it in a retrievable form in a facility designed for indefinite, low-maintenance operation.

The storage options in the PEIS are defined by the chemical form of the depleted uranium stored and the type of storage facility. Depleted uranium could be stored as UF_6, or, following chemical conversion, as U_3O_8 or UO_2. Storage as UF_6 would take place in cylinders similar to those currently used, whereas U_3O_8 or UO_2 would be stored in drums. Different types of storage facilities are considered for each chemical form (summarized in Table 6.1). For storage of UF_6 cylinders, the storage options considered include outdoor yards and aboveground buildings. For storage of U_3O_8 and UO_2 in drums, the storage options include aboveground buildings and belowground vaults. Each type of storage facility is described in Section 6.3.

TABLE 6.1 Summary of Depleted Uranium Chemical Forms and Storage Options Considered

	Storage Option Considered		
Chemical Form	Yards	Buildings	Vaults
UF_6	Yes	Yes	No
U_3O_8	No	Yes	Yes
UO_2	No	Yes	Yes

The choice of the chemical form of the depleted uranium for storage would depend in part on the desired end use or disposition of the material. For instance, storage in the form of UF_6 would provide maximum flexibility for future uses; however, UF_6 is not as chemically stable as other chemical forms because it becomes a gas at relatively low temperatures and is soluble in water. Storage in the form of UO_2 or U_3O_8 is attractive in view of their long-term stability, and may be the form of the material preferred for use as shielding or for disposal.

For this analysis, all storage facilities were assumed to be stand-alone, single-purpose facilities consisting of a central receiving building/warehouse surrounded by storage areas, all within a security fence. The storage facility would be capable of receiving containers of depleted uranium by truck or railcar, inspecting the containers, repackaging the material if necessary, and placing the containers into storage. Depending on the option, containers would be stored in a series of yards, buildings, or vaults. Once placed in storage, the containers of depleted uranium would require only routine monitoring and maintenance activities. The containers would be routinely inspected for damage or corrosion, the air would be monitored for indications of releases that would signify the presence of damaged containers, and any damaged containers would be repaired or replaced. The storage facilities would be designed to protect the stored material from the environment and prevent potential releases of material to the environment.

Potential environmental impacts would occur during (1) construction of a storage facility, (2) routine storage facility operations, and (3) potential storage accidents. The potential impacts during construction are generally limited to the duration of the construction period and result from typical land-clearing and construction activities. Potential impacts during operations would result primarily from the handling and inspection of containers. Impacts could also occur from potential accidents that release hazardous materials to the environment.

In general, the environmental impacts from the storage options were evaluated on the basis of information described in the engineering analysis report (LLNL 1997). For each storage option except storage as UF_6 in yards, the engineering analysis report provides preconceptual facility design data, including descriptions of facility layouts, resource requirements, estimates of effluents, wastes, and emissions, and estimates of potential accident scenarios. The design of facilities required for UF_6 storage in yards was partially based on current yard storage practices (Parks 1997), as well as the designs for building storage of UF_6 presented in the engineering analysis report (LLNL 1997). The assessment considers storage of depleted uranium through the year 2039. Storage facilities were assumed to receive containers of DOE-generated depleted uranium over a 20-year period beginning in 2009 and store the material for a period of 11 years after receipt of the last container.

In the PEIS, the analyses of the long-term storage options assumed that the three current storage sites were representative of sites that might actually be used for these activities. Analyses were conducted by using site-specific data for each of the three current storage sites (Paducah, Portsmouth, and K-25). After the analyses were completed, the results were aggregated and presented as a range that accounted for differences in the sites as well as differences in technologies that might be used in the future. For this report, ranges of impacts from the different long-term storage technologies examined in the PEIS are presented specifically for the Portsmouth site. Although the analyses for long-term storage used some data for the Portsmouth site, these analyses are not sufficient to completely fulfill NEPA requirements for site-specific environmental analyses for an actual long-term facility. For such analyses, detailed technology design and effluent data must be available, as well data on exactly where within the Portsmouth site the facilities would be located.

6.1 SUMMARY OF STORAGE OPTION IMPACTS

Potential environmental impacts for the storage options using the Portsmouth site as a representative location are summarized in Table 6.2. A more detailed assessment of specific storage technologies and site conditions will be conducted as appropriate as part of the second tier of the NEPA process.

After the draft PEIS was completed, management responsibility for approximately 11,200 additional cylinders of depleted UF_6 was transferred from USEC to DOE. To provide a bounding analysis of environmental impacts, the final PEIS evaluated the environmental impacts of managing an additional 15,000 cylinders. The impacts associated with long-term storage of the total inventory (including USEC-generated cylinders) at the Portsmouth site are summarized in Section 6.4 of this document. A summary of the estimated environmental impacts associated with long-term storage of the DOE-generated cylinders only and for the total cylinder inventory (DOE-generated plus USEC-generated) is presented in Table 6.2.

The following general conclusions can be drawn from the summary table:

- The environmental impacts from storage tend to be small for all chemical forms and types of storage facilities.

- For storage as UF_6, yard storage has slightly greater environmental impacts than storage in buildings.

- For storage as U_3O_8, the environmental impacts tend to be similar for buildings and vaults.

- For storage as UO_2, the environmental impacts tend to be similar for buildings and vaults.

TABLE 6.2 Summary of Impacts from Long-Term Storage Options for the Portsmouth Site[a]

A. UF_6

Impacts from Storage as UF_6 in Yards	Impacts from Storage as UF_6 in Buildings
Human Health – Normal Operations: Radiological	
Involved Workers: Total collective dose: 680 person-rem [880 person-rem] Total number of LCFs: 0.3 LCF [0.4 LCF]	**Involved Workers:** Total collective dose: 240 person-rem [310 person-rem] Total number of LCFs: 0.1 LCF
Noninvolved Workers: Negligible impacts	**Noninvolved Workers:** Negligible impacts
General Public: Negligible impacts	**General Public:** Negligible impacts
Human Health – Normal Operations: Chemical	
Noninvolved Workers: No impacts	**Noninvolved Workers:** No impacts
General Public: No impacts	**General Public:** No impacts
Human Health – Accidents: Radiological	
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence): Dose to MEI: 0.02 rem Risk of LCF to MEI: 8×10^{-6} Collective dose: 4.5 person-rem Number of LCFs: 2×10^{-3}	**Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 0.02 rem Risk of LCF to MEI: 8×10^{-6} Collective dose: 4.5 person-rem Number of LCFs: 2×10^{-3}
General Public: Bounding accident consequences (per occurrence): Dose to MEI: 0.013 rem Risk of LCF to MEI: 6×10^{-6} Collective dose to population within 50 miles: 27 person-rem Number of LCFs in population within 50 miles: 1×10^{-2} LCF	**General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.013 rem Risk of LCF to MEI: 6×10^{-6} Collective dose to population within 50 miles: 27 person-rem Number of LCFs in population within 50 miles: 1×10^{-2} LCF

TABLE 6.2 (Cont.)

Impacts from Storage as UF_6 in Yards	Impacts from Storage as UF_6 in Buildings
Human Health – Accidents: Chemical	
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects (bounding accident frequency: 1 in 100 years to 1 in 10,000 years): 520 persons	Number of persons with potential for adverse effects (bounding accident frequency: 1 in 100 years to 1 in 10,000 years): 520 persons
Number of persons with potential for irreversible adverse effects: 440 persons	Number of persons with potential for irreversible adverse effects: 440 persons
General Public: Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 580 persons	Number of persons with potential for adverse effects: 580 persons
Number of persons with potential for irreversible adverse effects: 0 persons	Number of persons with potential for irreversible adverse effects: 0 persons
Human Health — Accidents: Physical Hazards	
Construction and Operations: **All Workers:** 0.1 [0.13] fatality, approximately 92 [120] injuries	**Construction and Operations:** **All Workers:** 0.25 [0.33] fatality, approximately 150 injuries
Air Quality	
Construction: 24-hour PM_{10} concentration potentially as large as 20% of standard; concentrations of other criteria pollutants below 2% of respective standards	**Construction:** Annual NO_x concentration potentially as large as 3% of standard; concentrations of other criteria pollutants 1% or less of respective standards
Operations: 24-hour PM_{10} concentration potentially as large as 7% of standard; concentrations of other criteria pollutants below 1% of respective standards	**Operations:** Concentrations of all criteria pollutants 0.6% or less of respective standards
Water	
Construction: Negligible impacts to surface water and groundwater	**Construction:** Negligible impacts to surface water and groundwater
Operations: None to negligible impacts to surface water and groundwater	**Operations:** None to negligible impacts to surface water and groundwater

TABLE 6.2 (Cont.)

Impacts from Storage as UF_6 in Yards	Impacts from Storage as UF_6 in Buildings
Soil	
Construction: Moderate, but temporary, impacts	**Construction:** Moderate, but temporary, impacts
Operations: No impacts	**Operations:** No impacts
Excavation of soil: Change in topography from 256,000 yd^3 [323,000 yd^3] of excavated material	**Excavation of soil:** Change in topography from 157,000 yd^3 [211,000 yd^3] of excavated material
Socioeconomics	
Jobs: 100 peak year, construction; 50/year over 30 years, operations [60/year over 30 years, operations]	**Jobs:** 200 peak year, construction, 50/year over 30 years, operations [60/year over 30 years, operations]
Income: $5 million peak year, construction; $3 million/year over 30 years, operations [$4 million/year over 30 years, operations]	**Income:** $9 million peak year, construction, $3 million/year over 30 years, operations [$4 million/year over 30 years, operations]
Construction & Operations: Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances	**Construction & Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances
Ecology	
Loss of 144 [170] acres; potentially moderate to large impacts to vegetation and wildlife	Loss of 131 [165] acres; potentially moderate to large impacts to vegetation and wildlife
Waste Management	
Construction: Negligible to moderate, but temporary, impacts (solid waste)	**Construction:** Negligible to moderate, but temporary, impacts (solid waste)
Operations: Negligible impacts (all waste forms)	**Operations:** Negligible impacts (all waste forms)
Resource Requirements	
No impacts from resource requirements (such as electricity or materials) on the local or national scale are expected	No impacts from resource requirements (such as electricity or materials) on the local or national scale are expected
Land Use	
Use of approximately 144 [170] acres; potential moderate impacts	Use of approximately 131 [165] acres; potential moderate impacts

TABLE 6.2 (Cont.)

B. U_3O_8

Impacts from Storage as U_3O_8 in Buildings	Impacts from Storage as U_3O_8 in Vaults
Human Health – Normal Operations: Radiological	
Involved Workers: Total collective dose: 940 person-rem [1,200 person-rem]	**Involved Workers:** Total collective dose: 940 person-rem [1,200 person-rem]
Total number of LCFs: 0.4 LCF [0.5 LCF]	Total number of LCFs: 0.4 LCF [0.5 LCF]
Noninvolved Workers: Negligible impacts	**Noninvolved Workers:** Negligible impacts
General Public: Negligible impacts	**General Public:** Negligible impacts
Human Health – Normal Operations: Chemical	
Noninvolved Workers: No impacts	**Noninvolved Workers:** No impacts
General Public: No impacts	**General Public:** No impacts
Human Health – Accidents: Radiological	
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence): Dose to MEI: 7.4 rem	**Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 7.4 rem
Risk of LCF to MEI: 3×10^{-3}	Risk of LCF to MEI: 3×10^{-3}
Collective dose: 670 person-rem	Collective dose: 670 person-rem
Number of LCFs: 0.3	Number of LCFs: 0.3
General Public: Bounding accident consequences (per occurrence): Dose to MEI: 0.21 rem	**General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.21 rem
Risk of LCF to MEI: 1×10^{-4}	Risk of LCF to MEI: 1×10^{-4}
Collective dose to population within 50 miles: 7.9 person-rem	Collective dose to population within 50 miles: 7.9 person-rem
Number of LCFs in population within 50 miles: 4×10^{-3} LCF	Number of LCFs in population within 50 miles: 4×10^{-3} LCF

TABLE 6.2 (Cont.)

Impacts from Storage as U_3O_8 in Buildings	Impacts from Storage as U_3O_8 in Vaults
Human Health – Accidents: Chemical	
Bounding accident frequency: 1 in 100 years to 1 in 10,000 years	Bounding accident frequency: 1 in 100 years to 1 in 10,000 years
Noninvolved Workers: Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 1 person	Number of persons with potential for adverse effects: 1 person
Number of persons with potential for irreversible adverse effects: 0 persons	Number of persons with potential for irreversible adverse effects: 0 persons
General Public: Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 0 persons	Number of persons with potential for adverse effects: 0 persons
Number of persons with potential for irreversible adverse effects: 0 persons	Number of persons with potential for irreversible adverse effects: 0 persons
Human Health — Accidents: Physical Hazards	
Construction and Operations: **All Workers:** 0.29 [0.38] fatality, approximately 165 [220] injuries	**Construction and Operations:** **All Workers:** 0.26 [0.34] fatality, approximately 151 [200] injuries
Air Quality	
Construction: Annual NO_x concentration potentially as large as 2.2% of standard; all other criteria pollutant concentrations less than 0.7% of respective standards	**Construction:** Annual NO_x concentration potentially as large as 13% of standard; all other criteria pollutant concentrations less than 3% of respective standards
Operations: Concentrations of all criteria pollutants less than 0.2% of respective standards	**Operations:** Concentrations of all criteria pollutants less than 0.4% of respective standards
Water	
Construction: Negligible impacts to surface water and groundwater	**Construction:** Negligible impacts to surface water and groundwater
Operations: None to negligible impacts to surface water and groundwater	**Operations:** None to negligible impacts to surface water and groundwater

TABLE 6.2 (Cont.)

Impacts from Storage as U_3O_8 in Buildings	Impacts from Storage as U_3O_8 in Vaults
Soil	
Construction: Moderate, but temporary, impacts	**Construction:** Moderate, but temporary, impacts
Operations: No impacts	**Operations:** No impacts
Excavation of soil: Change in topography from 183,000 yd^3 [228,000 yd^3] of excavated material	**Excavation of soil:** Change in topography from 1.7 million yd^3 [2.3 million yd^3] of excavated material
Socioeconomics [b]	
Jobs: 170 peak year construction; 60/year over 30 years, operations [70/year over 30 years, operations]	**Jobs:** 210 peak year, construction; 60/year over 30 years, operations [70/year over 30 years, operations]
Income: $8 million peak year, construction, $3 million/year over 30 years, operations [$4 million/year over 30 years, operations]	**Income:** $9 million peak year, construction, $4 million/year over 30 years, operations [$5 million/year over 30 years, operations]
Construction and Operations: Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances	**Construction and Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances
Ecology	
Loss of 148 [173] acres; potentially moderate to large impacts to vegetation and wildlife	Loss of 212 [264] acres; potentially moderate to large impacts to vegetation and wildlife
Waste Management	
Construction: Minimal to moderate, but temporary, impacts (solid waste)	**Construction:** Minimal to moderate, but temporary, impacts (solid waste)
Operations: Negligible impacts (all waste forms)	**Operations:** Negligible impacts (all waste forms)
Resource Requirements	
No impacts from resource requirements (such as electricity or materials) on the local or national scale are expected	No impacts from resource requirements (such as electricity or materials) on the local or national scale are expected
Land Use	
Use of approximately 148 [173] acres; potential moderate impacts	Use of approximately 212 [264] acres; potential large impacts, including impacts from disposal of excavated material

TABLE 6.2 (Cont.)

C. UO_2

Impacts from Storage as UO_2 in Buildings	Impacts from Storage as UO_2 in Vaults
Human Health – Normal Operations: Radiological	
Involved Workers: Total collective dose: 540 person-rem [700 person-rem]	**Involved Workers:** Total collective dose: 540 person-rem [700 person-rem]
Total number of LCFs: 0.2 LCF [0.3 LCF]	Total number of LCFs: 0.2 LCF [0.3 LCF]
Noninvolved Workers: Negligible impacts	**Noninvolved Workers:** Negligible impacts
General Public: Negligible impacts	**General Public:** Negligible impacts
Human Health – Normal Operations: Chemical	
Noninvolved Workers: No impacts	**Noninvolved Workers:** No impacts
General Public: No impacts	**General Public:** No impacts
Human Health – Accidents: Radiological	
Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years	Bounding accident frequency: 1 in 10,000 years to 1 in 1 million years
Noninvolved Workers: Bounding accident consequences (per occurrence): Dose to MEI: 7.7 rem	**Noninvolved Workers:** Bounding accident consequences (per occurrence): Dose to MEI: 7.7 rem
Risk of LCF to MEI: 3×10^{-3}	Risk of LCF to MEI: 3×10^{-3}
Collective dose: 700 person-rem	Collective dose: 700 person-rem
Number of LCFs: 0.3	Number of LCFs: 0.3
General Public: Bounding accident consequences (per occurrence): Dose to MEI: 0.22 rem	**General Public:** Bounding accident consequences (per occurrence): Dose to MEI: 0.22 rem
Risk of LCF to MEI: 1×10^{-4}	Risk of LCF to MEI: 1×10^{-4}
Collective dose to population within 50 miles: 8.2 person-rem	Collective dose to population within 50 miles: 8.2 person-rem
Number of LCFs in population within 50 miles: 4×10^{-3} LCF	Number of LCFs in population within 50 miles: 4×10^{-3} LCF

TABLE 6.2 (Cont.)

Impacts from Storage as UO_2 in Buildings	Impacts from Storage as UO_2 in Vaults
Human Health – Accidents: Chemical	
Bounding accident frequency: 1 in 100 years to 1 in 10,000 years	Bounding accident frequency: 1 in 100 years to 1 in 10,000 years
Noninvolved Workers: Bounding accident consequences (per occurrence):	**Noninvolved Workers:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 1 person	Number of persons with potential for adverse effects: 1 person
Number of persons with potential for irreversible adverse effects: 0 persons	Number of persons with potential for irreversible adverse effects: 0 persons
General Public: Bounding accident consequences (per occurrence):	**General Public:** Bounding accident consequences (per occurrence):
Number of persons with potential for adverse effects: 0 persons	Number of persons with potential for adverse effects: 0 persons
Number of persons with potential for irreversible adverse effects: 0 persons	Number of persons with potential for irreversible adverse effects: 0 persons
Human Health — Accidents: Physical Hazards	
Construction and Operations: **All Workers:** 0.16 [0.21] fatality, approximately 111 [150] injuries	**Construction and Operations:** **All Workers:** 0.14 [0.18] fatality, approximately 104 [140] injuries
Air Quality	
Construction: Annual NO_x concentration potentially as large as 2% of standard; all other criteria pollutant concentrations 0.5% or less of respective standards	**Construction:** Annual NO_x concentration potentially as large as 11% of standard; all other criteria pollutant concentrations 3% or less of respective standards
Operations: All criteria pollutant concentrations 0.1% or less of respective standards	**Operations:** All criteria pollutant concentrations 0.2% or less of respective standards
Water	
Construction: Negligible impacts to surface water and groundwater	**Construction:** Negligible impacts to surface water and groundwater
Operations: None to negligible impacts to surface water and groundwater	**Operations:** None to negligible impacts to surface water and groundwater

TABLE 6.2 (Cont.)

Impacts from Storage as UO_2 in Buildings	Impacts from Storage as UO_2 in Vaults
Soil	
Construction: Moderate, but temporary, impacts	**Construction:** Moderate, but temporary, impacts
Operations: No impacts	**Operations:** No impacts
Excavation of soil: Change in topography from 81,000 yd^3 [101,000 yd^3] of excavated material	**Excavation of soil:** Change in topography from 750,000 yd^3 [1 million yd^3] of excavated material
Socioeconomics[b]	
Jobs: 120 peak year, construction; 70/year over 30 years, operations [80/year over 30 years, operations]	**Jobs:** 140 peak year, construction; 70/year over 30 years, operations [80/year over 30 years, operations]
Income: $5 million peak year, construction; $3 million/year over 30 years, operations [$4 million/year over 30 years, operations]	**Income:** $6 million peak year, construction; $3 million/year over 30 years, operations [$4 million/year over 30 years, operations]
Construction and Operations: Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances	**Construction and Operations:** Negligible to low impacts to ROI employment and population growth rates, vacant housing, and public finances
Ecology	
Potentially moderate impacts to vegetation and wildlife	Potentially large impacts to vegetation and wildlife
Waste Management	
Construction: Minimal to moderate, but temporary, impacts (solid waste)	**Construction:** Minimal to moderate, but temporary, impacts (solid waste)
Operations: Negligible impacts (all waste forms)	**Operations:** Negligible impacts (all waste forms)
Resource Requirements	
No impacts from resource requirements (such as electricity or materials) on the local or national scale are expected	No impacts from resource requirements (such as electricity or materials) on the local or national scale are expected
Land Use	
Use of approximately 79 [93] acres; potential moderate impacts	Use of approximately 114 [135] acres; potential moderate impacts

Footnotes appear on next page.

TABLE 6.2 (Cont).

[a] In general, the overall environmental consequences from managing the total cylinder inventory (total of USEC-generated and DOE-generated cylinders) are the same as those from managing the DOE-generated cylinders only. In this table, when the consequences for the total inventory differ from those for the DOE-generated cylinders only, the consequences for the total inventory are presented in brackets following the consequences for DOE cylinders only. LCF = latent cancer fatality; MEI = maximally exposed individual; NO_x = nitrogen oxides; PM_{10} = particulate matter with a mean diameter of 10 :m or less; ROI = region of influence.

[b] For construction, direct jobs and direct income are reported for the peak construction year. For operations, direct jobs and income are presented as annual averages. See Section 6.3.5 for details on indirect impacts in the Portsmouth site ROI.

- The differences in impacts among chemical forms are partially related to differences in material bulk densities, with denser material, such as UO_2, requiring less storage space. UF_6 storage impacts also consider the greater reactivity of this form and the small potential for release of HF gas. However, differences in environmental impacts among the forms tend to be small.

6.2 DESCRIPTION OF OPTIONS

This section provides a brief summary of the different storage options considered in the assessment of storage impacts. The information is based on preconceptual design data provided in the engineering analysis report (LLNL 1997). That report includes detailed information, such as descriptions of facility layouts, resource requirements, estimates of effluents, wastes, and emissions, and descriptions of potential accident scenarios.

The chemical form of the depleted uranium (i.e., whether it is UF_6, U_3O_8, or UO_2) determines the type of storage container, the total number of containers required, and the storage configuration (the way containers would be stacked). For storage of UF_6, U_3O_8, and UO_2, the following assumptions would apply to all storage facilities:

- The analysis of storage impacts for UF_6 was based on the assumption that UF_6 would be stored in cylinders meeting all applicable storage requirements, either the current cylinders or new cylinders. Cylinder preparation for transportation to a long-term storage site would require thorough inspection of the cylinders to determine that they meet transportation requirements; cylinders not meeting these requirements would be placed in overcontainers for shipment or would have their contents transferred to new cylinders. Cylinder preparation activities were assumed to be carried out so that the cylinders could be delivered to the long-term storage site and placed into storage without further preparation. However, a certain number of cylinders were assumed to be damaged during transport and handling, and the contents of these cylinders were assumed to be transferred to new cylinders at the long-term storage site.

- Depleted UF_6 cylinders would be stacked two high, as is the current practice for outside storage of these cylinders, in rows 1.2 m (4 ft) apart.

- U_3O_8 would be stored in powdered form in 55-gal (210-L) drums, consistent with current practice. Based on a bulk density of about 3 g/cm^3, the weight of a filled drum would be about 700 kg (1,600 lb). Approximately 714,000 55-gal drums would be required. The drums would be stored in rows of four-drum pallets, two pallets high. The width of each row would be about 1.2 m (4 ft), with 1 m (3 ft) between rows to allow for drum inspections.

- UO_2 would be stored in a sintered form in 30-gal (110-L) drums. Based on a bulk density of sintered UO_2 of about 9 g/cm^3, a filled 30-gal drum weighs about 1,100 kg (2,400 lb). Approximately 420,000 30-gal drums would be required. As with U_3O_8, the drums would be stored in rows of four-drum pallets, two pallets high. The width of each row would be about 1 m (3 ft), with 1 m (3 ft) between rows, to allow for drum inspections.

- For UF_6 cylinders and U_3O_8 and UO_2 drums, the contents of containers damaged during handling and storage would be transferred to new containers (0.7% of the drums containers received annually were assumed to require replacement [LLNL 1997]).

In these configurations, the total area required for storage would range from 131 to 144 acres (53 to 58 ha) for UF_6, from 148 to 212 acres (60 to 86 ha) for U_3O_8, and from 79 to 114 acres (32 to 46 ha) for UO_2. The storage areas differ primarily because the bulk densities differ between the chemical forms. Although the total storage area required differs among chemical forms, the basic designs of the storage facilities — yards, buildings, and vaults — would be similar for each. For instance, buildings of similar type would be used for the storage of UF_6, U_3O_8, and UO_2; however, 17 buildings would be required for storage of UF_6 cylinders, 20 buildings for storage of U_3O_8 drums, and only 9 buildings for storage of UO_2 drums. Because UF_6 is currently stored in cylinder yards at the three storage sites, long-term storage of UF_6 in cylinder yards at a single, centralized location was also examined.

The following sections provide a summary description of each of the storage options. Note that in addition to the primary storage units, each facility also would have an administration building, a receiving warehouse, a repackaging building (attached to the receiving warehouse), and a workshop. Storage facilities for UF_6 would require a cylinder washing facility to recover the heels from damaged cylinders after the removal of the UF_6.

6.2.1 Storage in Yards

Only depleted UF_6 would be stored in outdoor yards. Yard construction would be similar to current practice; the yards would consist of an 8-in. (20-cm) stabilized base under a 12-in. (30-cm) nonreinforced concrete pad. Twenty pads with dimensions of approximately 160 m × 80 m would be required. Additional facilities required for yard storage include a receiving warehouse and repackaging building, a cylinder washing building, and an administration building. Maintenance activities assessed for long-term yard storage are similar to those associated with the continued storage strategy (Parks 1997), and include routine inspections, ultrasonic inspections, valve monitoring and maintenance, and regular painting of the cylinders. The contents of any of the cylinders damaged during handling or storage would be subsequently transferred to new cylinders; the old cylinders would be washed and sent for further disposition.

6.2.2 Storage in Buildings

Storage in buildings is considered for UF_6, U_3O_8, and UO_2. Aboveground buildings would be built on-grade and consist of a concrete slab covered by a steel, preengineered, single-span structure. This type of building is commonly called a “Butler” building. Each building would be approximately 840 ft (260 m) long and 160 ft (50 m) wide, with a height of approximately 20 ft (6 m). The number of buildings required for storage of UF_6, U_3O_8, and UO_2 would be 17, 20, and 9, respectively. Construction would follow generally accepted practices. Additional facilities are provided which combine receiving/inspection operations with administration, shipping/unloading capabilities, and permanent monitoring capabilities (to ensure the integrity of the stored containers).

6.2.3 Storage in Vaults

Storage in vaults is considered for U_3O_8 and UO_2. Belowground vaults are subsurface reinforced concrete structures, 131 ft (40 m) wide × 266 ft (81 m) long, with a height of approximately 20 ft (6 m). The concrete walls are 1 ft (0.3 m) thick, with a floor slab thickness of 2 ft (0.6 m). The majority of the structure is located underground, with only the roof area above grade. A steel roof supported by trusses is used which can be removed to allow access to the vault by a mobile crane outside the structure. A total of 79 vaults would be required for storage of U_3O_8, and 35 for storage of UO_2.

6.2.4 Storage Technologies and Chemical Forms Considered But Not Analyzed

Storage of UF_6 in the potentially moist environment of a belowground vault was not considered due to potential accelerated corrosion of the steel cylinders. In addition, storage as depleted uranium metal was not considered because uranium metal is not as stable as U_3O_8 or UO_2, it is subject to surface oxidation.

6.3 IMPACTS OF OPTIONS

This section provides a summary of the potential environmental impacts associated with the storage options, including impacts from construction and facility operations. Detailed information related to the assessment methodologies for each area of impact is provided in Appendix C of the PEIS.

The environmental impacts from the storage options were evaluated based primarily on the information described in the engineering analysis report (LLNL 1997). The following general assumptions apply to storage facility operations:

- The assessment considers storage of depleted uranium through the year 2039.
- Two phases of facility operations are considered. Phase I beginning in 2009 corresponds to the first 20 years, when the facilities would receive UF_6 cylinders or UO_2 or U_3O_8 drums from off-site and place them into storage. Phase II corresponds to the next 11 years, when passive storage of cylinders or drums would take place. (When USEC cylinders are considered, the emplacement period is assumed to extend an additional 6 years through 2034 - see Section 6.4.)
- Construction of support buildings and initial storage facilities would begin about 2007, and additional storage facilities would be built as needed throughout Phase I.
- All storage containers would be routinely inspected, and any damaged containers would be replaced.
- UF_6 cylinder content transfers and empty cylinder washing activities would be the only sources of emissions associated with normal (nonaccident) operations. All U_3O_8 and UO_2 drum content transfers would be enclosed mechanical operations that would not involve material releases.

6.3.1 Human Health — Normal Operations

6.3.1.1 Radiological Impacts

Radiation doses and the associated cancer risks were estimated for exposed individuals and collective populations. Radiation doses to the involved workers would result mainly from external radiation during handling of containers of uranium and during routine inspection of containers. The doses were estimated by using information on the anticipated worker activities provided in the engineering analysis report (LLNL 1997). These activities included both involved and noninvolved workers. Special attention was given to estimating the number of involved workers, defined as those performing hands-on activities in the storage facility. Because the exact activities of each involved worker were not clear at this stage, estimating the individual dose for each worker was difficult. As a result, only the collective dose and average individual dose were calculated for involved workers. Spreadsheets listing the worker activities and the corresponding dose rates can be found on disk 3 of Cheng et al. (1997) under the file name store-tm.xls.

Radiation doses to noninvolved workers and the general public would result from release of uranium compounds to the environment. According to the engineering analysis report (LLNL 1997), airborne emissions of depleted uranium would be negligible during normal operations of the storage facilities. Results from water quality analyses (Section 6.3.4) also showed that potential impacts to surface water would be negligible. Therefore, radiological impacts to noninvolved workers and the off-site general public would be negligible for all storage options.

Discussion of the methodologies used in radiological impact analysis is provided in Appendix C of the PEIS and Cheng et al. (1997). The estimated results for involved workers are presented in Table 6.3 and 6.4 for all storage options. The results indicate that average radiation exposure to involved workers would be less than 920 mrem/yr.

6.3.1.1.1 Storage as UF_6

Radiation exposures for involved workers from storage as UF_6 would result mainly from cylinder handling, painting (for storage in yards), repackaging, and surveillance activities. Collective radiological impacts from storage in yards would be more than twice that from storage in buildings. Compared with buildings, storage in yards would require more cylinder inspection and cylinder maintenance (painting) activities to control corrosion in an outdoor environment. The collective dose would range from about 7.6 to 22 person-rem/yr (considering Phase I and Phase II) for a worker population of 19 to 26 individuals. The corresponding number of LCFs among the involved workers would range from 0.003 to 0.009 per year (1 to 3 LCFs over a 300-year period).

TABLE 6.3 Radiological Doses from Long-Term Storage Options under Normal Operations

	Dose to Receptor					
	Involved Worker[a]		Noninvolved Worker[b]		General Public[c]	
Option	Average Dose (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose (mrem/yr)	Collective Dose (person-rem/yr)
Storage as UF_6						
Yards	920	22	~ 0	~ 0	~ 0	~ 0
Buildings	290	7.6	~ 0	~ 0	~ 0	~ 0
Storage as U_3O_8						
Buildings	880	30	~ 0	~ 0	~ 0	~ 0
Vaults	910	30	~ 0	~ 0	~ 0	~ 0
Storage as UO_2						
Buildings	810	17	~ 0	~ 0	~ 0	~ 0
Vaults	670	17	~ 0	~ 0	~ 0	~ 0

[a] Involved workers are those workers directly involved with the handling of materials. Impacts are presented as average individual dose and collective dose for the worker population. Radiation doses to individual workers would be monitored by a dosimetry program and maintained below applicable standards, such as the DOE administrative control limit of 2,000 mrem/yr.

[b] Noninvolved workers are individuals who do not participate in material handling activities and individuals who work on-site but not within the facility. Because negligible airborne emission of radioactive materials would be expected from the storage facility (LLNL 1997), radiation doses to noninvolved workers would be negligible.

[c] The off-site general public is defined as residents who live within a radius of 50 miles (80 km) around the storage site. Radiation doses to the off-site public would be negligible because airborne emission of radioactive materials (LLNL 1997) and impacts to surface water quality would be negligible (Section 6.3.4).

TABLE 6.4 Latent Cancer Risks from Long-Term Storage Options under Normal Operations

	Latent Cancer Risk to Receptor					
	Involved Worker[a]		Noninvolved Workers[b]		General Public[c]	
Option	Average Risk (risk/yr)	Collective Risk (fatalities/yr)	MEI Risk (risk/yr)	Collective Risk (fatalities/yr)	MEI Risk (risk/yr)	Collective Risk (fatalities/yr)
Storage as UF_6						
Yards	4×10^{-4}	9×10^{-3}	~ 0	~ 0	~ 0	~ 0
Buildings	1×10^{-4}	3×10^{-3}	~ 0	~ 0	~ 0	~ 0
Storage as U_3O_8						
Buildings	4×10^{-4}	1×10^{-2}	~ 0	~ 0	~ 0	~ 0
Vaults	4×10^{-4}	1×10^{-2}	~ 0	~ 0	~ 0	~ 0
Storage as UO_2						
Buildings	3×10^{-4}	7×10^{-3}	~ 0	~ 0	~ 0	~ 0
Vaults	3×10^{-4}	7×10^{-3}	~ 0	~ 0	~ 0	~ 0

[a] Involved workers are those workers directly involved with the handling of materials. Impacts are presented as average individual risk and collective risk for the worker population.

[b] Noninvolved workers are individuals who do not participate in material handling activities and individuals who work on-site but not within the facility. Because negligible airborne emission of radioactive materials would be expected from the storage facility (LLNL 1997), cancer risks to noninvolved workers would be negligible.

[c] The off-site general public is defined as residents who live within a radius of 50 miles (80 km) around the storage site. Cancer risks to the off-site public would be negligible because airborne emission of radioactive materials (LLNL 1997) and impacts to surface water quality would be negligible (Section 6.3.4).

The average annual individual doses were obtained by dividing the collective dose by the number of workers. To provide a conservative estimate of doses, the calculations did not consider the implementation of as low as reasonably achievable (ALARA) practices to minimize exposures. Because the exact number of workers required to conduct all types of activities is uncertain at this preliminary stage, the estimated average individual doses also involve a large degree of uncertainty. The estimated average individual dose ranges from 290 to 920 mrem/yr for the storage options, with a corresponding individual risk of a latent cancer fatality of 0.0001 to 0.0004 per year (a chance of about 1 to 4 in 10,000 per year). The average individual dose would be well below the regulatory limit of 5,000 mrem/yr (10 CFR Part 835) and would be smaller than the DOE administrative control limit of 2,000 mrem/yr (DOE 1992).

6.3.1.1.2 Storage as U_3O_8

For storage as U_3O_8, the worker activities would be expected to be similar for the building and vault storage options. Therefore, radiological impacts to involved workers would be similar for these options. For the options, the estimated collective dose is about 30 person-rem/yr for 25 to 34 workers. The corresponding number of LCFs among workers would be about 0.01 per year (about 1 LCF over a 100-year period).

The estimated average individual dose ranges from about 880 to 910 mrem/yr for the U_3O_8 storage options, with a corresponding individual risk of a latent cancer fatality of 0.0004 per year (a chance of about 1 in 2,000). The average dose would be well below the regulatory dose limit of 5,000 mrem/yr.

Storage as U_3O_8 would result in greater collective exposures for involved workers than storage as UF_6 or UO_2 because a larger number of containers would be needed for U_3O_8 than for UF_6 and UO_2. Consequently, the number of operations for transferring containers, retrieving damaged containers, and surveying the stored inventory would be the greatest for U_3O_8 among the three chemical forms for depleted uranium.

6.3.1.1.3 Storage as UO_2

The storage practices for UO_2 drums would be similar to those for U_3O_8 drums; however, the total number of UO_2 drums would be less than the number of U_3O_8 drums. As a result, the estimated collective exposures to involved workers from drum handling and inspection activities would be less for UO_2 than for U_3O_8. On the other hand, the number of UO_2 drums would be greater than the number of UF_6 cylinders. Therefore, collective exposures for storage in buildings and in a mine would be greater for UO_2 than for UF_6.

Radiological impacts to workers would be similar among the UO_2 storage options. The collective dose to involved workers would be about 17 person-rem/yr for 19 to 26 workers. The corresponding number of latent cancer fatalities among workers would be about 0.007 per year (about 1 LCF over a 140-year period).

The estimated average individual dose ranges from 670 to 810 mrem/yr, with a corresponding individual risk of an LCF of about 0.0003 per year (a chance of about 1 in 2,500). The average dose would be well below the regulatory dose limit.

6.3.1.2 Chemical Impacts

Chemical impacts to the MEI were assessed for noninvolved workers and the public. However, according to the engineering analysis report (LLNL 1997), no airborne emissions of uranium would be expected for long-term storage facilities and only small quantities of HF would be emitted under the UF_6 storage option. Therefore, the only potential chemical exposures for noninvolved workers and the public that were considered are those that would result from airborne emissions of HF emitted from the cylinder transfer and washing operations. In addition, potential chemical exposures resulting from the storage facilities wastewater emissions were considered for the off-site general public; however, results from water quality analyses (Section 6.3.4.1) showed that potential impacts to surface water bodies would be negligible. Information on the methodologies used for the chemical impact analysis is provided in Appendix C of the PEIS and Cheng et al. (1997).

The results of the analysis of hazardous chemical human health impacts from long-term storage options are summarized in Table 6.5. No impacts on human health from chemical exposures would be expected during normal operations of storage facilities.

For the long-term storage option, the engineering analysis report (LLNL 1997) assumed that a low percentage of cylinders and drums would require repackaging annually due to handling or corrosion damage. These repackaging operations would result in the only potential releases and exposures to uranium and fluoride compounds for the storage options. For drum repackaging, electrically powered transfer equipment would pour the contents of the damaged drums into new drums, minimizing involved worker contact with the drum contents. The transfer equipment would operate in such a way as to keep the operation enclosed and eliminate dust generation for the U_3O_8 and UO_2 storage forms.

For storage as UF_6, repackaging would require heating the cylinder in an autoclave and transferring the contents to a new cylinder. A small "heel" of UF_6 (approximately 22 lb [10 kg]) would remain in the emptied cylinder; this material would be removed in the cylinder washing building, converted to UO_2F_2 and CaF_2, and disposed of. Small amounts of HF would be released from the cylinder washing building stack from the conversion of the UF_6 heels to UO_2F_2. The

TABLE 6.5 Chemical Impacts to Human Health for Long-Term Storage Options under Normal Operations

		Impacts to Receptor			
		Noninvolved Workers[a]		General Public[b]	
Option	Type	Hazard Index for MEI[c]	Collective Risk[d] (ind. at risk/yr)	Hazard Index for MEI[c]	Collective Risk[d] (ind. at risk/yr)
Storage as UF_6	Yards	~ 0	–	~ 0	–
	Buildings	~ 0	–	~ 0	–
Storage as U_3O_8	Buildings	~ 0	–	~ 0	–
	Vaults	~ 0	–	~ 0	–
Storage as UO_2	Buildings	~ 0	–	~ 0	–
	Vaults	~ 0	–	~ 0	–

[a] Noninvolved workers include individuals who work at the facility but are not involved in hands-on activities and individuals who work on-site but not within the facility. Because no airborne emission of uranium and/or very low levels of HF are expected from the storage facility, there would essentially be no noncarcinogenic health impacts to the noninvolved workers.

[b] The off-site general public is defined as residents who live with a radius of 50 miles (80 km) around the storage site. There would essentially be no noncarcinogenic health impacts to the general public because no airborne emission of uranium and/or very low levels of HF are expected from the storage facility, there would essentially be no noncarcinogenic health impacts to the noninvolved workers.

[c] The hazard index is an indicator for potential health effects other than cancer; a hazard index greater than 1 indicates a potential for adverse health effects and a need for further evaluation.

[d] Calculation of population risk is not applicable when the corresponding hazard index for the MEI is less than 1.

maximum annual emission of HF for the Phase I and Phase II operational periods of long-term UF_6 storage would be about 0.10 kg/yr (in yards). In comparison, the maximum estimated annual emission of HF for any of the depleted UF_6 conversion options would be 408 kg/yr. Therefore, the maximum estimated annual emission of HF from any of the UF_6 storage facilities would be more than 4,000 times lower than the maximum annual emission of HF from conversion facilities. Because the results of the conversion analyses (Chapter 5) did not indicate any human health impacts and the atmospheric release and transport of HF would occur under similar conditions, the small quantities of HF present in the storage facility emissions would also not result in human health impacts.

For storage as UF_6, it should also be noted that emissions due to breaches were not assumed because all cylinders would be inspected once every 4 years and would be repackaged immediately if any handling or corrosion damage was identified. Additionally, yard storage assumes that rigorous maintenance would take place, such as ultrasonic test inspections, valve monitoring, and regular painting.

Airborne emissions of depleted uranium are not expected during normal operations of the storage facilities, according to data provided in the engineering analysis report (LLNL 1997). Therefore, no matter which chemical form of depleted uranium is selected, chemical impacts to noninvolved workers and the off-site general public would be negligible.

6.3.2 Human Health — Accident Conditions

For long-term storage as U_3O_8 and UO_2, a range of accidents covering the spectrum of high-frequency/low-consequence accidents to low-frequency/high-consequence accidents was presented in the engineering analysis report (LLNL 1997). Accidents analyzed for long-term storage in yards were consistent with those analyzed for continued cylinder storage, as given in the safety analysis reports (LMES 1997a,b,c). These accidents are listed in Table 6.6. The following sections present the results for radiological and chemical health impacts of the highest consequence accident in each frequency category, using the Portsmouth site as representative. Results for all accidents listed in Table 6.6 are presented in Policastro et al. (1997). Detailed descriptions of the methodology and assumptions used in these calculations are also provided in Appendix C of the PEIS and Policastro et al. (1997).

6.3.2.1 Radiological Impacts

The radiological doses to various receptors for the accidents that would result in the highest dose from each frequency category are listed in Table 6.7. The LCF risks for these accidents are given in Table 6.8. The doses and the risks are presented as ranges (maximum and minimum) because two different meteorological conditions were considered for each long-term storage option, using the Paducah site as representative. The doses and risks presented here were obtained by assuming that the accidents would occur. The probability of occurrence for each accident is indicated by the frequency category to which it belongs. For example, accidents in the extremely unlikely category have a probability of occurrence between 1 in 10,000 and 1 in 1 million in any 1 year. The following conclusions may be drawn from the radiological health impact results:

- No cancer fatalities would be predicted from any of the accidents.

- The maximum radiological dose to noninvolved worker and general public MEIs (assuming an accident occurred) would be 7.7 rem. This dose is less than the 25-rem dose recommended for assessing the adequacy of protection of public health and safety from potential accidents by the NRC (1994).

TABLE 6.6 Accidents Considered for the Long-Term Storage Options

Option/Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Storage as UF_6					
Likely Accidents (frequency: 1 or more times in 100 years)					
Corroded cylinder spill, dry conditions	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the dry ground.	UF_6	24	60 (continuous)	Ground
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Corroded cylinder spill, wet conditions – rain	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area on the wet ground.	HF	96	60 (continuous)	Ground
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Corroded cylinder spill, wet conditions – water pool	A 1-ft hole results during handling, with solid UF_6 forming a 4-ft^2 area into a 0.25-in. deep water pool.	HF	150	60 (continuous)	Ground
Vehicle-induced fire, 3 full 48G cylinders	Three full 48G UF_6 cylinders hydraulically rupture during a fire resulting from the ignition of fuel and/or hydraulic fluid from the transport vehicle, etc.	UF_6	0 11,500 8,930 3,580	0 to 12 12 12 to 30 30 to 121	Ground
Incredible Accidents (frequency: less than 1 in 1 million years)					
Small plane crash, 2 full 48G cylinders	A small plane crash affects two full 48G UF_6 cylinders. One cylinder hydraulically ruptures during a fire resulting from the ignition of aviation fuel.	UF_6	0 3,840 2,980 1,190	0 to 12 12 12 to 30 30 to 121	Ground
	The second cylinder is initially breached due to impact with aircraft debris, followed by sublimation due to fire.	UF_6	4,240 1,190	0 to 30 30 to 121	Ground
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA
Storage as U_3O_8					
Likely Accidents (frequency: 1 or more times in 100 years)					
Mishandling/drop of drum/ billet inside the repackaging building	A single U_3O_8 drum is damaged by a forklift and spills its contents onto the ground inside the repackaging building.	U_3O_8	0.00028	Puff	Stack
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Earthquake	The repackaging building is damaged during a design-basis earthquake, resulting in failure of the structure and confinement systems.	U_3O_8	33	30	Ground
Tornado	A major tornado and associated tornado missiles result in failure of the repackaging building structure and its confinement systems.	U_3O_8	33	0.5	Ground

TABLE 6.6 (Cont.)

Option/Accident Scenario	Accident Description	Chemical Form	Amount (lb)	Duration (min)	Release Level[a]
Storage as U_3O_8 (Cont.)					
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Fire or explosion inside the repackaging building	A fire or explosion within the repackaging facility affects the contents of a single pallet of drums.	U_3O_8	0.0011	Puff	Stack
Incredible Accidents (frequency: less than 1 in 1 million years)					
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA
Storage as UO_2					
Likely Accidents (frequency: 1 or more times in 100 years)					
Mishandling/drop of drum/ billet inside the repackaging building	A single UO_2 drum is damaged by a forklift and spills its contents onto the ground inside the repackaging building.	UO_2	0.00011	Puff	Stack
Unlikely Accidents (frequency: 1 in 100 years to 1 in 10,000 years)					
Earthquake	The repackaging building is damaged during a design-basis earthquake, resulting in failure of the structure and confinement systems.	UO_2	33	30	Ground
Tornado	A major tornado and associated tornado missiles result in failure of the repackaging building structure and its confinement systems.	UO_2	33	0.5	Ground
Extremely Unlikely Accidents (frequency: 1 in 10,000 years to 1 in 1 million years)					
Fire or explosion inside the repackaging building	A fire or explosion within the repackaging facility affects the contents of a single pallet of drums.	UO_2	0.00045	Puff	Stack
Incredible Accidents (frequency: less than 1 in 1 million years)					
Flood	The facility would be located at a site that would preclude severe flooding.	No release	NA	NA	NA

[a] Ground-level releases were assumed to occur outdoors on concrete pads in the cylinder storage yards. To prevent contaminant migration, cleanup of residuals was assumed to begin immediately after the release was stopped.

TABLE 6.7 Estimated Radiological Doses per Accident Occurrence for the Long-Term Storage Options at the Portsmouth Site

		Maximum Dose[c]				Minimum Dose[c]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Option/Accident[a]	Frequency Category[b]	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)	MEI (rem)	Population (person-rem)
Storage as UF_6									
Corroded cylinder spill, dry conditions	L	7.7×10^{-2}	7.1	2.2×10^{-3}	1.4×10^{-1}	3.3×10^{-3}	2.8×10^{-1}	9.3×10^{-5}	2.2×10^{-2}
Vehicle-induced fire, 3 full 48G cylinders	EU	2.0×10^{-2}	4.5	1.3×10^{-2}	2.7×10^{1}	3.7×10^{-3}	7.5×10^{-1}	1.9×10^{-3}	5.2×10^{-1}
Small plane crash, 2 full 48G cylinders	I	6.6×10^{-3}	1.5	4.3×10^{-3}	1.8×10^{-1}	8.7×10^{-4}	2.3×10^{-1}	6.2×10^{-4}	2.5×10^{-2}
Storage as U_3O_8									
Mishandling/drop of drum inside the repackaging building	L	9.4×10^{-9}	7.7×10^{-10}	9.7×10^{-9}	1.8×10^{-6}	2.8×10^{-12}	8.1×10^{-25}	4.8×10^{-10}	2.3×10^{-7}
Earthquake	U	7.4	6.7×10^{2}	2.1×10^{-1}	7.9	3.1×10^{-1}	2.7×10^{1}	8.9×10^{-3}	2.0
Fire or explosion inside the repackaging building	EU	3.6×10^{-8}	2.9×10^{-9}	3.7×10^{-8}	6.7×10^{-6}	1.1×10^{-11}	3.1×10^{-24}	1.8×10^{-9}	8.6×10^{-7}
Storage as UO_2									
Mishandle/drop of drum inside the repackaging building	L	3.7×10^{-9}	3.0×10^{-10}	3.8×10^{-9}	7.0×10^{-7}	1.1×10^{-12}	3.2×10^{-25}	1.9×10^{-10}	8.9×10^{-8}
Earthquake	U	7.7	7.0×10^{2}	2.2×10^{-1}	8.2	3.2×10^{-1}	2.8×10^{1}	9.2×10^{-3}	2.1
Fire or explosion inside the repackaging building	EU	1.5×10^{-8}	1.2×10^{-9}	1.5×10^{-8}	2.8×10^{-6}	4.4×10^{-12}	1.3×10^{-24}	7.5×10^{-10}	3.6×10^{-7}

[a] The bounding accident chosen to represent each frequency category is the one that would result in the highest dose to the general public MEI. Health impacts in that row represent that accident only and not the range of accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

[b] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[c] Maximum and minimum doses reflect differences in assumed technologies and meteorological conditions at the time of the accident, which is assumed to occur at the center of the site. In general, maximum doses would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum doses would occur under D stability with 4 m/s wind speed.

TABLE 6.8 Estimated Radiological Health Risks per Accident Occurrence for the Long-Term Storage Options at the Portsmouth Site[a]

		Maximum Risk[d] (LCFs)				Minimum Risk[d] (LCFs)			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Option/Accident[b]	Frequency Category[c]	MEI	Population	MEI	Population	MEI	Population	MEI	Population
Storage as UF_6									
Corroded cylinder spill, dry conditions	L	3×10^{-5}	3×10^{-3}	1×10^{-6}	7×10^{-5}	1×10^{-6}	1×10^{-4}	5×10^{-8}	1×10^{-5}
Vehicle-induced fire, 3 full 48G cylinders	EU	8×10^{-6}	2×10^{-3}	6×10^{-6}	1×10^{-2}	1×10^{-6}	3×10^{-4}	1×10^{-6}	3×10^{-4}
Small plane crash, 2 full 48G cylinders	I	3×10^{-6}	6×10^{-4}	2×10^{-6}	9×10^{-5}	3×10^{-7}	9×10^{-5}	3×10^{-7}	1×10^{-5}
Storage as U_3O_8									
Mishandle/drop of drum inside the repackaging building	L	4×10^{-12}	3×10^{-13}	5×10^{-12}	9×10^{-10}	1×10^{-15}	3×10^{-28}	2×10^{-13}	1×10^{-10}
Earthquake	EU	3×10^{-3}	3×10^{-1}	1×10^{-4}	4×10^{-3}	1×10^{-4}	1×10^{-2}	4×10^{-6}	1×10^{-3}
Fire or explosion inside the repackaging building	I	1×10^{-11}	1×10^{-12}	2×10^{-11}	3×10^{-9}	4×10^{-15}	1×10^{-27}	9×10^{-13}	4×10^{-10}
Storage as UO_2									
Mishandle/drop of drum inside the repackaging building	L	1×10^{-12}	1×10^{-13}	2×10^{-12}	3×10^{-10}	4×10^{-16}	1×10^{-28}	9×10^{-14}	4×10^{-11}
Earthquake	EU	3×10^{-3}	3×10^{-1}	1×10^{-4}	4×10^{-3}	1×10^{-4}	1×10^{-2}	5×10^{-6}	1×10^{-3}
Fire or explosion inside the repackaging building	I	6×10^{-12}	5×10^{-13}	8×10^{-12}	1×10^{-9}	2×10^{-15}	5×10^{-28}	4×10^{-13}	2×10^{-10}

a Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (LCFs) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

b The bounding accident chosen to represent each frequency category is the one that would result in the highest risk to the general public MEI. Health impacts in that row represent that accident only and not the range of accidents in that category. Absence of an accident in a certain frequency category indicates that the accident would not result in a release of radioactive material.

c Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

d Maximum and minimum risks reflect differences in assumed technologies and meteorological conditions at the time of the accident, which is assumed to occur at the center of the site. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

- The overall radiological risk to noninvolved worker and general public MEI receptors (estimated by multiplying the risk per occurrence [Table 6.8] by the annual probability of occurrence by the number of years of operations) would be less than 1 for all accidents.

6.3.2.2 Chemical Impacts

The accidents considered in this section are listed in Table 6.6. The results of the accident consequence modeling in terms of chemical impacts are presented in Tables 6.9 and 6.10. The results are presented as (1) number of people with potential for adverse effects and (2) number of people with potential for irreversible adverse effects. The tables present the results for the accident within the frequency category that would affect the largest number of people (total of noninvolved workers and off-site population) (Policastro et al. 1997). The numbers of noninvolved workers and members of the off-site public represent the impacts if the associated accident was assumed to occur. The accidents listed in Tables 6.9 and 6.10 are not identical because an accident with the largest impacts for the adverse effects endpoint might not lead to the largest impacts for the irreversible adverse effects endpoint. The results of the chemical impacts analysis may be summarized as follows:

- If the accidents identified in Tables 6.9 and 6.10 did occur, the number of persons in the off-site population with potential for adverse effects would range from 0 to 580 (maximum corresponding to vehicle-induced fire accident involving three full 48G cylinders), and the number of off-site persons with potential for irreversible adverse effects was estimated to be 0.

- If the accidents identified in Tables 6.9 and 6.10 did occur, the number of noninvolved workers with potential for adverse effects would range from 0 to 520 (maximum corresponding to the corroded cylinder spill accident with rain conditions), and the number of noninvolved workers with potential for irreversible adverse effects would range from 0 to 440 (maximum corresponding to corroded cylinder spill accident with pooling).

- The noninvolved worker population would receive the majority of the severe impacts and the off-site population much less, except for the vehicle-induced fire accident involving three full 48G cylinders. In such case, the plume would rise and hit the ground at distances downwind. The overall risk (frequency times consequence), however, is very low due to the low frequency of occurrence.

TABLE 6.9 Number of Persons with Potential for Adverse Effects from Accidents under the Long-Term Storage Options at the Portsmouth Site[a]

		Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
Option/Accident[b]	Frequency Category[c]	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Storage as UF_6									
Yard									
Corroded cylinder spill, dry conditions	L	Yes	240	No	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	520	Yes	10	Yes	190	No	0
Vehicle-induced fire, three full 48G cylinders	EU	Yes	260	Yes	580	Yes	2	Yes	4
Small plane crash, 48G cylinders	I	Yes	200	Yes	19	Yes	2	No	0
Buildings									
Corroded cylinder spill, dry conditions	L	Yes	240	No	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	520	Yes	10	Yes	190	No	0
Vehicle-induced fire, 3 full 48G cylinders	EU	Yes	260	Yes	580	Yes	2	Yes	4
Small plane crash, 2 full 48G cylinders	I	Yes	200	Yes	19	Yes	2	No	0
Storage as U_3O_8									
Mishandle/drop of drum/ cylinder inside[f]	L	No	0	No	0	No	0	No	0
Earthquake	U	Yes	1	No	0	No	0	No	0
Fire or explosion involving reagent inside[f]	EU	No	0	No	0	No	0	No	0
Storage as UO_2									
Mishandle/drop of drum/ cylinder inside[f]	L	No	0	No	0	No	0	No	0
Earthquake	U	Yes	1	No	0	No	0	No	0
Fire or explosion involving reagent inside[f]	EU	No	0	No	0	No	0	No	0

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times 31 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site people) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations ($> 10^{-2}$/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations ($10^{-2} - 10^{-4}$/yr); extremely unlikely (EU), estimated to occur between once in 10,000 years and once in 1 million years of facility operations ($10^{-4} - 10^{-6}$/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations ($< 10^{-6}$/yr).

[d] Maximum and minimum values reflect different meteorological conditions at the time of the accident, which is assumed to occur at the center of the site. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either “Yes” or “No” for potential adverse effects to an individual.

[f] These accidents would result in the largest plume sizes, although no people would be affected.

TABLE 6.10 Number of Persons with Potential for Irreversible Adverse Effects from Accidents under the Long-Term Storage Options at the Portsmouth Site[a]

Option/Accident[b]	Frequency Category[c]	Maximum Number of Persons[d]				Minimum Number of Persons[d]			
		Noninvolved Workers		General Public		Noninvolved Workers		General Public	
		MEI[e]	Population	MEI[e]	Population	MEI[e]	Population	MEI[e]	Population
Storage as UF_6									
Yard									
Corroded cylinder spill, dry conditions	L	Yes	3	No	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	370	Yes[f]	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	440	Yes[f]	0	Yes	4	No	0
Small plane crash, 2 full 48G cylinders	I	Yes	2	No	0	Yes	1	No	0
Buildings									
Corroded cylinder spill, dry conditions	L	Yes	3	No	0	No	0	No	0
Corroded cylinder spill, wet conditions – rain	U	Yes	370	Yes[f]	0	Yes	3	No	0
Corroded cylinder spill, wet conditions – water pool	EU	Yes	440	Yes[f]	0	Yes	4	No	0
Small plane crash, 2 full 48G cylinders	I	Yes	2	No	0	Yes	1	No	0
Storage as U_3O_8									
Mishandle/drop of drum/cylinder inside[g]	L	No	0	No	0	No	0	No	0
Earthquake	U	Yes[f]	0	No	0	No	0	No	0
Fire or explosion involving reagent inside[g]	EU	No	0	No	0	No	0	No	0
Storage as UO_2									
Mishandle/drop of drum/cylinder inside[g]	L	No	0	No	0	No	0	No	0
Earthquake	U	Yes[f]	0	No	0	No	0	No	0
Fire or explosion involving reagent inside[g]	EU	No	0	No	0	No	0	No	0

[a] Values shown are the consequences if the accident did occur. The risk of an accident is the consequence (number of persons) times the estimated frequency times 20 years of operations. The estimated frequencies are as follows: likely (L) = 0.1; unlikely (U) = 0.001; extremely unlikely (EU) = 0.00001; incredible (I) = 0.000001.

[b] The bounding accident chosen to represent each frequency category is the one in which the largest number of people (workers plus off-site people) would be affected. Health impacts in that row represent that accident only and not the range of impacts among accidents in that category.

[c] Accident frequencies: likely (L) = estimated to occur one or more times in 100 years of facility operations (> 10^{-2}/yr); unlikely (U) = estimated to occur between once in 100 years and once in 10,000 years of facility operations (10^{-2} – 10^{-4}/yr); extremely unlikely (EU) = estimated to occur between once in 10,000 years and once in 1 million years of facility operations (10^{-4} – 10^{-6}/yr); incredible (I) = estimated to occur less than one time in 1 million years of facility operations (< 10^{-6}/yr).

[d] Maximum and minimum values reflect different meteorological conditions at the time of the accident, which is assumed to occur at the center of the site. In general, maximum risks would occur under meteorological conditions of F stability with 1 m/s wind speed, whereas minimum risks would occur under D stability with 4 m/s wind speed.

[e] At the MEI location, the determination is either “Yes” or “No” for potential irreversible adverse effects to an individual.

[f] MEI locations were evaluated at 100 m from ground-level releases for workers and at the location of highest off-site concentration for members of the general public; the population risks are 0 because the worker and general public population distributions for the representative sites were used, which did not show receptors at the MEI locations.

[g] These accidents would result in the largest plume sizes, although no people would be affected.

- The impacts resulting from the vehicle-induced fire involving three full 48G UF_6 cylinders would be large for members of the general public in terms of potential adverse effects because of the considerable source terms associated with such an accident.

- The overall impact for accidents associated with long-term storage as UF_6 in buildings would be about the same as that associated with storage in a yard. Storage as U_3O_8 would have almost the same impacts as storage as UO_2, with both options having very small impacts compared with the potential impacts for storage as UF_6.

- Stack releases would have much lower impacts than ground-level releases.

- The maximum risk was computed as the product of the consequence (number of people) times the frequency of occurrence (per year) times the number of years in operations (31 years, 2009 through 2039). The results indicated that the maximum risk values would be less than 1 for all accidents except the following:

  - *Potential Adverse Effects:*

    Corroded cylinder spill, dry conditions (L, likely), workers
    Corroded cylinder spill, wet conditions – rain (U, unlikely), workers

  - *Potential Irreversible Adverse Effects:*

    Corroded cylinder spill, dry conditions (L, likely), workers
    Corroded cylinder spill, wet conditions – rain (U, unlikely), workers

These risk values are conservative because the numbers of people affected were based on assuming (1) meteorological conditions that would result in the maximum reasonably foreseeable plume size (i.e., F stability and 1 m/s wind speed) and (2) wind in the direction that would lead to maximum numbers of individuals exposed for noninvolved workers or for the general population.

To aid in the interpretation of accident analysis results, the number of fatalities potentially associated with the estimated potential irreversible adverse effects was estimated. All the bounding case accidents shown in Table 6.10 would involve releases of UF_6 and potential exposure to HF and uranium compounds. These exposures would likely be high enough to result in death for 1% or less of the persons experiencing irreversible adverse effects (Policastro et al. 1997). This would mean that for noninvolved workers experiencing a range of 0 to 440 irreversible adverse effects, 0 to about 4 deaths would be expected. No deaths would be expected among the general public. These are the maximum potential consequences of the accidents, the upper ends of the ranges assume worst-case weather conditions and that the wind would be blowing in the direction where the highest numbers of people would be exposed.

6.3.2.3 Physical Hazards

The risk of on-the-job fatalities and injuries to all long-term storage facility workers is calculated using industry-specific statistics from the Bureau of Labor Statistics, as reported by the National Safety Council (1995). Construction and manufacturing annual fatality and injury rates were used respectively for the duration of the construction and operational phases of the facility.

No on-the-job fatalities are predicted for any of the storage options analyzed (range of 0.10 for UF_6 yard storage to 0.29 for U_3O_8 building storage, for the total construction, Phase I operations, and Phase II operations). The range of predicted injuries is about 92 to 165 for the entire facility lifetimes. Physical hazard risks of fatality and injury are presented in Table 6.11 by construction, Phase I, and Phase II components. The largest component of physical hazard risks generally results from construction; in general, construction physical hazard risks are 3 to 4 times greater than risks from Phase I and II operations combined. The overall differences in ranges of physical hazard risks between chemical forms and storage types are fairly small.

For storage as UF_6, the probability of an on-the-job fatality ranges from 0.10 for storage in yards to 0.25 for storage in buildings — including construction, Phase I, and Phase II of storage. The predicted injury incidence ranges from about 92 to 150 injuries over the lifetime of the facility.

TABLE 6.11 Potential Impacts to Human Health from Physical Hazards under Accident Conditions for the Long-Term Storage Options

	Impacts to All Long-Term Storage Facility Workers[a]					
	Incidence of Fatalities[b]			Incidence of Injuries[b]		
Option	Construction	Phase I Operations	Phase II Operations	Construction	Phase I Operations	Phase II Operations
Storage as UF_6	0.04 – 0.20	0.04	0.02	16 – 72	48 – 53	25 – 29
Storage as U_3O_8	0.20 – 0.23	0.04	0.02	72 – 83	55 – 57	25
Storage as UO_2	0.09 – 0.10	0.04	0.02	33 – 37	50	22 – 24

[a] Impacts are reported as ranges, which result from variations in the employment requirements for the different long-term storage chemical forms and facility types. All construction and operational workers at the storage facilities are included in physical hazard risk calculations.

[b] Fatality and injury incidence rates used in the calculations were taken from National Safety Council (1995).

For storage as U_3O_8, the probability of an on-the-job fatality ranges from 0.26 for storage in vaults to 0.29 for storage in buildings — including construction, Phase I, and Phase II of storage. The predicted injury incidence ranges from about 151 to 165 injuries over the lifetime of the facility.

For storage as UO_2, the probability of an on-the-job fatality ranges from 0.14 for storage in vaults to 0.16 for storage in buildings — including construction, Phase I, and Phase II of storage. The predicted injury incidence ranges from about 104 to 111 injuries over the lifetime of the facility.

6.3.3 Air Quality

The methodology used to analyze impacts of the long-term storage options is described in Appendix C and Tschanz (1997a). The storage site was assumed to be centered within the Portsmouth site boundaries, and pollutant concentrations — CO, HC, NO_x, SO_x, and PM_{10}— were estimated at the boundaries. Screening modeling of construction emissions was used to estimate hourly pollutant concentrations under very conservative meteorological conditions at the boundary point that would be the shortest distance from the center of the site. The maximum 1-hour concentrations are shown in Table 6.12. These impacts would occur when construction was underway at the corner of the storage site nearest the site boundary. Concentrations from construction at the center of the storage site would be 1.5 to 2 times smaller than the ones listed in the table. Among the listed results, the PM_{10} values might require close consideration in actual

TABLE 6.12 Maximum 1-Hour Pollutant Concentrations at the Portsmouth Site Boundaries as a Result of Emissions from Constructing the Long-Term Storage Facility under Worst-Case Meteorological Conditions

	Maximum 1-Hour Concentration (: g/m³)				
	Aboveground Building Storage			Belowground Vault Storage	
Pollutant	UF_6	U_3O_8	UO_2	U_3O_8	UO_2
CO	74	90	52	280	130
HC	33	36	20	110	53
NO_x	370	430	240	1,300	640
SO_x	25	29	16	85	42
PM_{10}[a]	350	400	230	460	240

[a] Fugitive dust emissions from land disturbance have been included with PM_{10} emissions from construction equipment to estimate total PM_{10} concentrations.

construction of any storage facilities similar to the assumed preconceptual ones. On the basis of the size of the estimated 1-hour concentrations, it is possible that, under particularly unfavorable conditions, concentrations could exceed the 24-hour PM_{10} standard of 150 µg/m^3.

The maximum impacts of CO and NO_x at the site boundaries during operations to place depleted uranium in storage are shown in Table 6.13 for the averaging periods for which standards exist. In all cases, the concentrations due to the storage operations are 1% or less of the standards. Although not shown, the comparisons between SO_x concentrations and the corresponding standards are similar to those for CO.

The emissions from routine monitoring and maintenance following completion of the storage operations in all cases would be less than 25% as large as the operations emissions. Thus, in all cases, the maintenance air quality impacts would be less than 25% of the operations impacts alone.

Some of the estimated criteria pollutant impacts during the operations phase of long-term storage of UF_6 in yards, when both construction and operations would occur simultaneously, are shown in Table 6.14. Construction would be the dominant contributor to most of the impacts, accounting for between 75% of the total for CO to nearly 100% for PM_{10}. The combined impacts of construction and operations would be below the relevant standards, although closer examination of the likely PM_{10} impacts might be required if this option were to be implemented.

In the maintenance phase of UF_6 storage in yards, the impacts would be similar to those of operations without construction. The maintenance impacts for CO, NO_x, and PM_{10} would be 0.71, 0.76, and 0.77, respectively, of those listed for operations in Table 6.14.

TABLE 6.13 Maximum Pollutant Concentrations at the Portsmouth Site Boundaries from Operations Emissions during Long-Term Storage

	CO				NO_x	
	1-Hour Average		8-Hour Average		Annual Average	
Option	Pollutant Concentration (µg/m^3)	Percent of Standard at Maximum	Pollutant Concentration (µg/m^3)	Percent of Standard at Maximum	Pollutant Concentration (µg/m^3)	Percent of Standard at Maximum
Aboveground Buildings						
Storage as UF_6	6.2	0.02	1.7	0.02	0.48	0.5
Storage as U_3O_8	6.8	0.02	1.9	0.02	0.57	0.6
Storage as UO_2	6.4	0.02	1.7	0.02	0.39	0.4
Belowground Vaults						
Storage as U_3O_8	9.3	0.02	2.6	0.03	0.95	1.0
Storage as UO_2	10.1	0.03	2.9	0.03	0.82	0.8

TABLE 6.14 Maximum Pollutant Concentrations at Facility Boundaries during Operations for the Long-Term Storage of Depleted UF_6 in Yards

Pollutant	Averaging Time	Pollutant Concentration (: g/m^3) Construction	Pollutant Concentration (: g/m^3) Operations	Maximum of Construction and Operations as Percent of Standard
CO	1 hour	14	4.3	0.04
	8 hours	2.0	1.0	0.03
NO_x	Annual	0.21	0.022	0.2
PM_{10}	24 hours	11	0.012	7.1
	Annual	0.64	0.0021	1.3

Only small quantities of HF would be released from the process stack, averaging 0.06 kg/yr during the operations phase and 0.012 kg/yr during the maintenance phase. The estimated maximum average annual HF concentration is about 2×10^{-6} : g/m^3.

No quantitative estimate was made of the impacts on the criterion pollutant ozone. Ozone formation is a regional issue that would be affected by emissions data for the entire area around a proposed long-term storage site. The pollutants most related to ozone formation that would result from the long-term storage of depleted UF_6 are HC and NO_x. In later Phase II studies, when specific technologies and sites would be selected, the potential effects on ozone of these pollutants at a proposed site could be put in perspective by comparing them with the total emissions of HC and NO_x in the surrounding area. Small additional contributions to the totals would be unlikely to alter the ozone attainment status of the region.

6.3.4 Water and Soil

The methodology used to determine water and soil impacts is presented in Appendix C of the PEIS and Tomasko (1997b).

6.3.4.1 Surface Water

To evaluate construction impacts, it was conservatively assumed that construction at the Portsmouth site would be completed in 1 year. Essentially negligible impacts to surface water would be expected for all long-term storage options.

6.3.4.1.1 Buildings

The total land requirements for aboveground storage in buildings would be greatest for storing depleted uranium as U_3O_8 (148 acres [60 ha]) (Table 6.15). Of this area, about 70 acres (29 ha) would be disturbed, and 6 acres (2.4 ha) would be paved. This alteration of soil would impact surface waters by increasing the amount of runoff. At the Portsmouth site, however, this amount of increased impermeable land would have a negligible impact on nearby rivers (0.2% of the area available for runoff). In addition, there would be no measurable impacts to the existing floodplains.

Water would be needed for constructing the storage buildings. As indicated in Table 6.15, the total quantity of water ranges from about 0.3 million gal/yr (0.6 gpm) for the UO_2 storage option to about 0.6 million gal/yr (1.1 gpm) for storing depleted uranium as U_3O_8. Because this water would be obtained from groundwater wells, there would be no impact to surface water.

During construction, wastewater would be discharged to nearby surface waters. About 0.05 million gal/yr (0.1 gpm) of water would be discharged for the U_3O_8 option (see Table 6.15). The

TABLE 6.15 Summary of Environmental Parameters for Long-Term Storage in Buildings

	Requirements		
Option	Storage as UF_6	Storage as U_3O_8	Storage as UO_2
Total land area (acres)	131	148	79
Total disturbed land (acres)	62	72	35
Total paved area (acres)	5	6	4
Excavation yd^3	157,000	183,000	81,000
Water (million gal/yr)			
Construction	0.5	0.6	0.3
Phase I	1.2	1.4	1.1
Phase II	1.0	1.0	0.9
Wastewater (million gal/yr)			
Construction	0.05	0.06	0.03
Phase I	1.1	1.2	1.1
Phase II	0.9	0.9	0.8

primary contaminants of concern would be construction chemicals, organics, and some suspended solids. By following good engineering practices (e.g., stockpiling materials away from surface water drainages, covering construction piles with tarps, and cleaning small chemical spills as soon as they occurred), concentrations in the wastewater would be expected to be very small and well within any regulatory standards. In addition, once in the nearby surface water, a dilution of more than 20 million:1 for average flows in the Scioto River would occur. Because the levels of contamination from construction would be very low, impacts to sediment would also be negligible.

During Phase I, annual water use would range from 1.1 to 1.4 million gal/yr for the three storage forms (UF_6, UO_2, and U_3O_8) (Table 6.15). For a constant rate of use, the maximum requirement would be about 35 gpm. This water would be obtained from groundwater wells, so there would be no impacts to the Scioto River.

Impacts to surface water quality could also occur during Phase I and II. These impacts would result from releasing water containing chemicals or radionuclides. The maximum wastewater release of 1.2 million gal/yr (2.3 gpm) would occur during Phase I (Table 6.15). This wastewater would contain low concentrations of pollutants that would be within NPDES guidelines. Additional large dilution would occur in the receiving water.

Impacts to surface waters during Phase II would be even less than the impacts produced by Phase I operations because of smaller volumes of wastewater released (Table 6.15). Impacts to surface water would therefore be negligible.

None of the accident scenarios presented in LLNL (1997) would produce impacts to surface water. Accidents occurring within the concrete-bottomed buildings would be contained and isolated from surface water, and accidents in which the building fails would primarily produce potential impacts via the air pathway.

6.3.4.1.2 Vaults

The total land requirements for vault storage would be roughly similar to the requirements for building storage (Table 6.16). The amount of increased impermeable land would have a negligible impact on the Scioto River. In addition, there would be no measurable impacts to floodplains, and the quantity of water needed for constructing vaults would be similar to that needed for constructing buildings.

During Phase I and Phase II operations, annual water use would be about two times greater than for the building option (Table 6.16). Because this water would be obtained from groundwater wells, there would be no surface water impacts.

TABLE 6.16 Summary of Environmental Parameters for Long-Term Storage in Vaults

Option	Physical Needs	
	Storage as U_3O_8	Storage as UO_2
Total land area (acres)	212	114
Total disturbed area (acres)	86	40
Total paved area (acres)	21	10
Excavation (million yd^3)	1.7	0.75
Water (million gal/yr)		
Phase I	1.1	1.2
Phase II	0.8	0.9
Wastewater (million gal/yr)		
Construction	0.8	0.4
Phase I	1.1	1.0
Phase II	0.9	0.8

None of the accident scenarios presented in LLNL (1997) would produce impacts to surface water. If an accident occurred within the vault, it would be contained and isolated from surface water.

6.3.4.1.3 Yards

For long-term storage of depleted uranium as UF_6 in yards, 144 acres (58 ha) of land would be disturbed and 13 acres (5.3 ha) would be paved. This alteration of soil would impact local surface waters by increasing the amount of runoff. The amount of increased runoff, however, would be negligible on a sitewide scale because the land area affected would be about 0.4% of the land area available. In addition there would be no measurable impacts to the existing floodplains.

Water would be needed for construction of the long-term storage yards and for their subsequent operation. Approximately 6.4 million gal/yr of water would be required. This quantity of water would be obtained from groundwater wells. Therefore, there would be no impacts to the Scioto River.

During construction of the storage yard, surface water quality could be impacted. The primary contaminants of concern would be chemicals used in construction, organic compounds, and some suspended solids. By following good engineering practices, concentrations in the wastewater would be expected to be very small and less than applicable EPA guidelines. Once the construction water mixed with surface water, dilution would occur. Depending on the volume of water released during construction, dilution would be about 20 million:1.

During normal operations, there would be no emissions that would impact surface water because all cylinders are assumed to be new at the start of the storage option, they would be inspected once every 4 years, and they would be replaced if any handling damage occurred. In addition, no impacts to surface water would result from accidents because no accidents are identified in LLNL (1997) that would produce emissions that would interact directly or indirectly with surface water.

6.3.4.2 Groundwater

Groundwater impacts for long-term storage in yards, buildings, or vaults could result from activities during construction and normal operations. At Portsmouth, these impacts would be produced by groundwater withdrawals needed to meet the water demands and accidental releases that could affect the groundwater quality.

During construction, the most water would be required for constructing yards (6.4 million gal/yr) (12.2 gpm). This water would be obtained from groundwater wells. Current groundwater use at Portsmouth is about 14 million gal/d (9,722 gpm). The additional water needed for construction would represent an increase of about 0.1%. Impacts from this increment in groundwater extraction would be negligible.

During normal operations, the largest water demand would occur during Phase I for a vault (approximately 3 gpm). This additional withdrawal would represent an increase of about 0.03%, which would have a negligible impact on the groundwater system.

For vault construction, drains would be provided on the upgradient side of the facility to prevent groundwater from entering the facility and mobilizing any spilled contaminants. Accident sequences described in LLNL (1997) would also have no impacts on groundwater because the building, vault, or mine would isolate contaminants and eliminate any direct pathways to the underlying aquifers.

Groundwater quality could also be impacted by construction. For example, chemicals stored on the ground could be mobilized by precipitation and infiltrate to the underlying aquifers. By adopting good engineering and construction practices (e.g., covering material to prevent interaction with rain, promptly cleaning any chemical spills, and providing retention basins to catch and hold contaminated runoff), groundwater concentrations would be kept below EPA (1996) guidelines. Overall, impacts from construction would therefore be negligible. Phase I and Phase II operations would have no impacts on groundwater quality because there would be no direct discharges of wastewater to the aquifers.

The only groundwater impacts for long-term storage in yards would occur during construction. These impacts would primarily be to groundwater quality; impacts to the depth of groundwater, recharge, and flow direction would not be measurable on a sitewide scale. For example, chemicals stored on the ground could be mobilized by precipitation and infiltrate to the underlying aquifers. By adopting good engineering and construction practices, impacts to quality would be minimized, and groundwater concentrations would be kept below EPA (1996) guidelines.

As with surface water, there would be no emissions that would impact groundwater during normal operations because all cylinders were assumed to be in good condition at the start of the storage option, they would be inspected once every 4 years, and they would be replaced if any handling damage occurred. In addition, no accident scenarios identified in LLNL (1997) would lead to direct or indirect groundwater contamination.

6.3.4.3 Soil

6.3.4.3.1 Buildings

The only impacts to soil from long-term storage in buildings would occur during construction. The maximum impact would occur for construction of the U_3O_8 building (Table 6.15). Up to 148 acres (60 ha) of land (4% of the land area available) would be disturbed, and 183,000 yd^3 (140,000 m^3) of soil would be excavated. These impacts would include modifications in the local topography, increased permeability and erosion potential in areas where the land surface is plowed, decreased permeability and erosion potential in areas where the soil is compacted by heavy equipment, and decreased soil quality in areas exposed to chemical alteration. On a sitewide scale, the impacts would be moderate; however, the impacts would be temporary. That is, with time the disturbed soil conditions would return to previous conditions everywhere except in paved lots. As discussed in Section 6.3.4.1.1, this area would be about 6 acres (2.4 ha) (0.2% of the total land area available). On a sitewide scale, this impact would be negligible.

By following good engineering practices (e.g., disturbing as little soil as possible, contouring and reseeding disturbed land, scheduling activities to minimize land disturbance, controlling runoff, using tarps to prevent chemical/rainfall interaction, and cleaning any spills as soon as they occur), impacts to soils would be minimized.

6.3.4.3.2 Vaults

The only impacts to soil from long-term storage in vaults would occur during construction. The largest impact to soils would occur for construction of the U_3O_8 vault (Table 6.15). Up to 212 acres (86 ha) of land (6% of the land area available) would be disturbed, and up to 1.7 million yd^3 (1.3 million m^3) of soil would be excavated. These impacts would include modifications in the local topography. If the excavated soil were spread evenly over the 212-acre (86-ha) facility, a mound 5 ft (1.5 m) deep would be created. This impact could be mitigated by trucking the soil off-site. Other impacts would include increased permeability and erosion potential in areas where the land surface is plowed or mounded, decreased permeability and erosion potential in areas where the soil is compacted by heavy equipment, and decreased soil quality in areas exposed to chemical alteration. On a sitewide scale, the impacts would be moderate; however, the impacts would, to a large extent, be temporary and readily mitigated. With time the disturbed soil conditions would be returned to existing conditions everywhere except in paved lots. As discussed in Section 6.3.4.1.2, this area would be a maximum of 21 acres (8.5 ha) (0.6% of the total land area available). On a sitewide scale, this impact would be minor. By following good engineering practices, impacts to soils would be kept to a minimum.

6.3.4.3.3 Yards

About 144 acres (58 ha) of land would be disturbed by construction of the long-term storage yard facility (4% of the land area available). Of this area, 13 acres (5.3 ha) would be paved (0.4% of the land area available). In addition, about 250,000 yd^3 (192,000 m^3) of soil would be excavated. Impacts from construction would include modifications in topography, increased permeability and erosion potential in areas where the soil would be broken, decreased permeability and erosion potential in areas where the soil would be compacted by heavy equipment or paving, and decreased soil quality in areas subjected to chemical loading. On a sitewide basis, the impacts would be moderate, but they would be mostly temporary. That is, with time, soil conditions would return to previous conditions everywhere except beneath paved lots, the UF_6 storage pads, and associated buildings. By following good engineering practices, impacts to soils would be kept to a minimum.

There would be no emissions that would impact soils during normal operations because all cylinders would be inspected once every 4 years, and they would be replaced if any handling damage occurred. In addition, there are no identified accident scenarios that would lead to direct or indirect contamination.

6.3.5 Socioeconomics

Calculations for the analysis of socioeconomic impacts were based on detailed cost data developed for trial storage facilities, including the impacts of facility construction, operation and maintenance, emplacement and closure, and surveillance and monitoring activities. Impacts for each facility are presented for the peak year of construction; operations values are annual averages for the emplacement period.

The potential socioeconomic impacts of long-term storage in yards, buildings, and vaults were estimated by using the Portsmouth site as representative. The impacts of long-term storage at the site on regional economic activity were estimated. The methodology for assessing socioeconomic impacts is discussed in Appendix C of the PEIS.

Long-term storage would probably have a small impact on socioeconomic conditions in the ROI surrounding the site described in Section 2.8. This is partly because a major proportion of expenditures associated with procurement for the construction and operation of each technology option would flow outside of the ROI to other locations in the United States, reducing the concentration of local economic effects of the long-term storage facility.

Slight changes in employment and income would occur in the ROI as a result of local spending of personal consumption expenditures derived from employee wages and salaries, local procurement of goods and services required to construct and operate a long-term storage facility, and other local investment associated with construction and operation. In addition to creating new (direct) jobs at the site, the facility would also create indirect employment and income in the ROI as a result of jobs and procurement expenditures at the site. Jobs and income created directly by a long-term storage facility, together with indirect activity in the ROI, would contribute slightly to reduction in unemployment in the ROI surrounding the site. Minimal impacts are expected on local population growth and, consequently, on local housing markets and local fiscal conditions.

The effects of constructing and operating long-term storage facilities were assessed with regard to regional economic activity (measured in terms of employment and personal income) and population, housing, and local public revenues and expenditures. Table 6.17 presents the potential range of impacts for long-term storage options.

6.3.5.1 Long-Term Storage as UF_6

During the peak year of construction of a UF_6 long-term storage yard or building, 100 to 200 direct jobs would be created at the site, and 80 to 160 additional jobs would be indirectly created in the ROI surrounding the site (Table 6.17) as a result of the spending of employee wages and

TABLE 6.17 Potential Socioeconomic Impacts of the Long-Term Storage Options for Yards, Buildings, and Vaults

	Long-Term Storage as UF_6		Long-Term Storage as UO_2		Long-Term Storage as U_3O_8	
Parameter	Construction[a]	Operations[b]	Construction[a]	Operations[b]	Construction[a]	Operations[b]
Economic activity in the ROI						
Direct jobs	100 – 200	50	120 – 140	70	170 – 210	60
Indirect jobs	80 – 160	30	100	30 – 40	140 – 150	40
Total jobs	180 – 360	80	220 – 240	100 – 110	310 – 360	100
Income ($ million)						
Direct income	5 – 9	3	5 – 6	3	8 – 9	3 – 4
Total income	7 – 12	3 – 4	7 – 8	4	11 – 12	5 – 6
Population in-migration into the ROI	190 – 400	60	220 – 260	80 – 90	320 – 390	80 – 90
Housing demand						
Number of units in the ROI	70 – 140	20	80 – 100	30	120 – 140	30
Public finances						
Change in ROI fiscal balance (%)	0.1 – 0.2	0.03	0.1	0.04	0.2	0.04

[a] Impacts are for peak year of construction, either 2007 or 2008. Socioeconomic impacts from construction were assessed for 2007 through 2028.

[b] Impacts are the annual averages for the emplacement period (2009–2028). Annual averages for the surveillance and maintenance period (2029–2039) were estimated to be equal to or less than these values.

salaries and procurement-related expenditures. Overall, between 180 and 360 jobs would be created. Construction activity would also produce direct and indirect income in the ROI, with total income of \$7 million to \$12 million produced during the peak year. In the first year of operations of the facility, 80 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI surrounding each site, with total income of \$3 to 4 million in the first year. Construction and operation of a UF_6 storage facility would result in an increase in the projected baseline compound annual average growth rate in employment in the site ROI of less than 0.1 percentage point from 2006 through 2039.

Construction of a UF_6 storage facility would be expected to generate direct in-migration of 130 to 280 in the peak year of construction. Additional indirect job in-migration would be expected into the site ROI, bringing the total number of in-migrants to between 190 and 400 in the peak year (Table 6.17). Operation of the facility would be expected to generate direct job in-migration of 40 in the first year. Additional indirect job in-migration into the ROI would also be expected, bringing the total number of in-migrants to 60 in the first year of operations. Construction and operation of a UF_6 storage facility would result in an increase in the projected baseline compound annual average growth rate in the site ROI population of less than 0.1 percentage point from 2006 through 2039.

A UF_6 storage facility would generate a demand for 70 to 140 additional rental housing units during the peak year of construction (Table 6.17), representing an impact of 3.5 to 7.2% on the projected number of vacant rental housing units at the site. A demand for 20 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 0.4 to 0.5% on the number of vacant owner-occupied housing units at the site.

During the peak year of construction, between 190 and 140 persons would in-migrate into the ROI at the site, leading to an increase of 0.1 to 0.2% over ROI-forecasted baseline revenues and expenditures at the site (Table 6.17). In the first year of operations, 60 in-migrants would be expected, leading to an increase of 0.03% in local revenues and expenditures at the site.

6.3.5.2 Long-Term Storage as UO_2

During the peak year of construction of a UO_2 long-term storage building or vault, 120 to 140 direct jobs would be created at the site and 100 indirect jobs would be created in the ROI surrounding the site (Table 6.17) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, between 220 and 240 jobs would be created. Construction activity would also produce direct and indirect income in the ROI, with total income of \$7 million to \$8 million produced during the peak year. In the first year of operations of the facility, between 110 and 110 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI surrounding the site, with total income of \$4 million in the first year. Construction and operation of a UO_2 storage facility would result in an increase in the projected baseline compound annual average growth rate in employment in the ROI of 0.01 percentage point from 2006 to 2039.

Construction of a UO_2 storage facility would be expected to generate direct in-migration of 160 to 190 in the peak year of construction. Additional indirect job in-migration would be expected into the site ROI, bringing the total number of in-migrants to between 220 and 260 in the peak year (Table 6.17). Operation of the facility would be expected to generate direct job in-migration of between 60 and 70 in the first year. Additional indirect job in-migration into the ROI would also be expected, bringing the total number of in-migrants to between 80 and 90 in the first year of operations. Construction and operation of a UO_2 storage facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of 0.01 percentage point from 2006 to 2039.

A UO_2 storage facility would generate a demand for 80 to 100 additional rental housing units during the peak year of construction, representing an impact of 4.2 to 4.8% on the projected number of vacant rental housing units at the site (Table 6.17). A demand for 30 additional owner-occupied housing units would be expected in the first year of operations, representing an impact of 0.6% on the number of vacant owner-occupied housing units at the site.

During the peak year of construction, between 220 and 260 persons would in-migrate into the Portsmouth ROI, leading to an increase of 0.1% over ROI-forecasted baseline revenues and expenditures at the site (Table 6.17). In the first year of operations, 80 to 90 in-migrants would be expected, leading to an increase of 0.04% in local revenues and expenditures at the site.

6.3.5.3 Long-Term Storage as U_3O_8

During the peak year of construction of a U_3O_8 long-term storage building or vault, 170 to 210 direct jobs would be created at the site and 140 to 150 indirect jobs would be created in the ROI surrounding the site (Table 6.17) as a result of the spending of employee wages and salaries and procurement-related expenditures. Overall, between 310 and 340 jobs would be created. Construction activity would also produce direct and indirect income in the ROI, with total income of $11 million to $12 million produced during the peak year. In the first year of operations of the facility, 100 direct and indirect jobs would be created. Direct and indirect income would also be produced in the ROI surrounding the site, with total income of $5 million to $6 million in the first year. Construction and operation of a U_3O_8 storage facility would result in an increase in the projected baseline compound annual average growth rate in employment in the ROI of less than 0.1 percentage point from 2006 through 2039.

Construction of a U_3O_8 storage facility would be expected to generate direct in-migration of 230 to 290 in the peak year of construction. Additional indirect job in-migration would be expected into the site ROI, bringing the total number of in-migrants to between 320 and 390 in the peak year (Table 6.19). Operation of the facility would be expected to generate direct job in-migration of 60 to 70 in the first year. Additional indirect job in-migration into the ROI would also be expected, bringing the total number of in-migrants to between 80 and 90 in the first year of operations. Construction and operation of a U_3O_8 storage facility would result in an increase in the projected baseline compound annual average growth rate in ROI population of less than 0.1 percentage point from 2006 through 2039.

A U_3O_8 storage facility would generate a demand for 120 to 140 additional rental housing units during the peak year of construction, corresponding to an impact of 6.0 to 7.2% on the projected number of vacant rental housing units at the site (Table 6.17). A demand for 30 additional owner-occupied housing units would be expected in the first year of operations, corresponding to an impact of 0.3 to 0.8% on the number of vacant owner-occupied housing units at the site.

During the peak year of construction, between 320 and 390 persons would in-migrate into the ROI at the site, leading to an increase of about 0.2% over ROI-forecasted baseline revenues and expenditures at the site (Table 6.17). In the first year of operations, 80 to 90 in-migrants would be expected, leading to an increase of 0.04% in local revenues and expenditures at the site.

6.3.6 Ecology

Moderate to large adverse impacts to ecological resources could result from construction of a facility for long-term storage as UF_6, U_3O_8, or UO_2. Impacts could include mortality of individual organisms, habitat loss, or changes in biotic communities. Impacts due to operation of a storage facility would be negligible.

6.3.6.1 Storage as UF_6

Site preparation for the construction of a facility to store UF_6 in buildings would require the disturbance of approximately 131 acres (53 ha), including the permanent replacement of about 62 acres (25 ha) of current land cover with structures and paved areas. Existing vegetation would be destroyed during land-clearing activities. The vegetation communities that would be eliminated by site preparation would depend on the location of the facility. Communities occurring on undeveloped land at the Portsmouth site are relatively common and well represented in the vicinity of the site; however, impacts to high-quality native plant communities might occur if facility construction required disturbance to vegetation communities outside of the currently fenced areas. Construction of the storage facility would not be expected to threaten the local population of any species. The loss of up to 131 acres (53 ha) of undeveloped land would constitute a large adverse impact to vegetation. Erosion of exposed soil at the construction site could reduce the effectiveness of restoration efforts and create sedimentation downgradient of the site. The implementation of standard erosion control measures, installation of storm-water retention ponds, and immediate replanting of disturbed areas with native species would help minimize impacts to vegetation. Impacts due to facility construction are shown in Table 6.18.

Wildlife would be disturbed by land clearing, noise, and human presence. Wildlife with restricted mobility, such as burrowing species or juveniles of nesting species, would be destroyed during land clearing activities. More mobile individuals would relocate to adjacent available areas with suitable habitat. Population densities and competition would increase in these areas, potentially reducing the chances of survival or reproductive capacity of displaced individuals. Some wildlife species would be expected to quickly recolonize replanted areas near the storage facility following completion of construction. The permanent loss of 62 acres (25 ha) to 131 acres (53 ha) of habitat would not be expected to threaten the local population of any wildlife species since similar habitat would be available in the vicinity of the site. However, habitat use in the vicinity of the facility may be reduced for some species due to the construction of a perimeter fence enclosing a 131-acre (53-ha) area. Overall, construction of a facility for UF_6 storage would be considered a moderate to large adverse impact to wildlife.

Impacts to surface water and groundwater quality during construction are expected to be negligible (Section 6.3.4). Thus, construction derived impacts to aquatic biota would also be expected to be negligible. Wetlands could potentially be filled or drained during construction. In addition, impacts to wetlands due to alteration of surface water runoff patterns, soil compaction, or groundwater flow could occur if the storage facility were located immediately adjacent to wetland areas. However, impacts to wetlands would be minimized by maintaining a buffer area around wetlands during construction of the facility. Unavoidable impacts to wetlands would require a *Clean Water Act* Section 404 permit, which might stipulate mitigative measures. Additional permitting might be required by state agencies.

Critical habitat has not been designated for any state or federally listed threatened or endangered species at the site. Prior to construction of a storage facility, a survey for state and federally listed threatened, endangered, or candidate species, or species of special concern would be conducted so that, if possible, impacts to these species could be avoided. Where impacts were unavoidable, appropriate mitigation could be developed.

Small releases of HF would be expected to occur during operation of the building storage facility. The maximum average annual air concentration of HF from facility operations would be less than 2×10^{-6} : g/m^3, well below levels injurious to wildlife. Resulting impacts to wildlife would be negligible.

TABLE 6.18 Impacts to Ecological Resources from Construction of Long-Term Storage Facilities for Depleted Uranium

Option/Resource	Buildings	Vaults	Yards
Storage as UF_6			
Vegetation	Loss of 131 acres Large adverse impact	Not applicable[a]	Loss of 144 acres Large adverse impact
Wildlife	Loss of 62 to 131 acres Moderate to large adverse impact	Not applicable	Loss of 77 to 144 acres Large adverse impact
Aquatic species	Negligible impact	Not applicable	Negligible impact
Wetlands	Potential adverse impact	Not applicable	Potential adverse impact
Protected species	Potential adverse impact	Not applicable	Potential adverse impact
Storage as U_3O_8			
Vegetation	Loss of 148 acres Large adverse impact	Loss of 212 acres Large adverse impact	Not applicable[a]
Wildlife	Loss of 72 to 148 acres Large adverse impact	Loss of 86 to 212 acres Large adverse impact	Not applicable
Aquatic species	Negligible impact	Negligible impact	Not applicable
Wetlands	Potential adverse impact	Potential adverse impact	Not applicable
Protected species	Potential adverse impact	Potential adverse impact	Not applicable
Storage as UO_2			
Vegetation	Loss of 79 acres Moderate adverse impact	Loss of 114 acres Large adverse impact	Not applicable[a]
Wildlife	Loss of 35 to 79 acres Moderate adverse impact	Loss of 40 to 114 acres Large adverse impact	Not applicable
Aquatic species	Negligible impact	Negligible impact	Not applicable
Wetlands	Potential adverse impact	Potential adverse impact	Not applicable
Protected species	Potential adverse impact	Potential adverse impact	Not applicable

[a] Long-term storage as UF_6 in vaults and long-term storage as U_3O_8 or UO_2 in yards were not considered.

Impacts due to construction of a facility to store UF_6 in yards would be similar to impacts from storage in buildings, although a larger area would be affected. Facility construction would require the disturbance of approximately 144 acres (58 ha), including the permanent replacement of approximately 90 acres (37 ha) with buildings and paved areas. Compared with the building storage facility, a smaller proportion of the yard storage facility would be available for wildlife habitat. Construction of a facility to store UF_6 in yards would constitute a large adverse impact to vegetation and wildlife. Potential impacts associated with facility construction are shown in Table 6.18.

Small releases of HF, UO_2F_2, and U_3O_8 would be expected to occur during operation of the yard storage facility due to transfers of UF_6 from defective cylinders. The maximum annual average air concentration at the site boundary from operation of a yard storage facility would be less than 2.8×10^{-6} : g/m^3 for HF, 5.3×10^{-7} : g/m^3 for UO_2F_2, and 1.8×10^{-9} : g/m^3 for U_3O_8. Impacts to wildlife from these emissions are expected to be negligible.

Storage facility accidents could result in adverse impacts to ecological resources. The affected species and degree of impact would depend on such factors as location of the accident, season, and meteorological conditions.

6.3.6.2 Storage as U_3O_8

The construction of a facility to store U_3O_8 in buildings would generally result in the types of impacts associated with UF_6 building storage. Site preparation for the construction of a facility to store U_3O_8 in buildings would require the disturbance of approximately 148 acres (60 ha), including the permanent replacement of approximately 72 acres (29 ha) of current land cover with structures and paved areas. Construction of the storage facility would not be expected to threaten the local population of any species. The loss of up to 148 acres (60 ha) of undeveloped land would constitute a large adverse impact to vegetation. Releases of contaminants are not expected to occur during operation of the storage facility, therefore, impacts to biotic resources due to facility operation would be negligible. Impacts due to facility construction are shown in Table 6.18.

The permanent loss of 72 to 148 acres (29 to 60 ha) of habitat would not be expected to threaten the local population of any wildlife species since similar habitat would be available in the vicinity of the site. However, habitat use in the vicinity of the facility might be reduced for some species due to the construction of a perimeter fence enclosing a 148-acre (60-ha) area. Therefore, construction of a facility for U_3O_8 storage in buildings would be considered a large adverse impact to wildlife.

Impacts to surface water and groundwater quality during construction are expected to be negligible (Section 6.3.4). Thus, construction derived impacts to aquatic biota would also be expected to be negligible.

Impacts due to construction of a facility to store U_3O_8 in vaults would be similar to impacts from storage in buildings, although a larger area would be affected. Facility construction would require the disturbance of approximately 212 acres (86 ha), including the permanent replacement of approximately 86 acres (35 ha) with structures and paved areas. A larger proportion of the vault storage facility would be available for wildlife habitat in comparison with the building storage facility. Species diversity and abundance, however, would be expected to be low because of human presence, proximity of buildings, and the relatively poor habitat quality of landscaped areas. Construction of a facility to store U_3O_8 in vaults would constitute a large adverse impact to vegetation and wildlife. The larger size of the facility also would increase the potential for unavoidable direct and indirect impacts to wetlands due to facility location. Impacts due to facility construction are shown in Table 6.18. Releases of contaminants are not expected to occur during operation of the vault storage facility, therefore, impacts to biotic resources due to facility operation would be negligible.

6.3.6.3 Storage as UO_2

The construction of a facility to store UO_2 in buildings would generally result in the types of impacts associated with UF_6 building storage. Site preparation for the construction of a facility to store UO_2 in buildings would require the disturbance of approximately 79 acres (32 ha), including the permanent replacement of approximately 35 acres (14 ha) with structures, including paved areas. Construction of the storage facility would not be expected to threaten the local population of any species. The loss of up to 79 acres (32 ha) of undeveloped land would constitute a moderate adverse impact to vegetation. Impacts due to facility construction are shown in Table 6.18.

The permanent loss of 35 to 79 acres (14 to 32 ha) of habitat would not be expected to threaten the local population of any wildlife species because similar habitat would be available in the vicinity of the site. However, habitat use in the vicinity of the facility might be reduced for some species due to the construction of a perimeter fence enclosing a 79-acre (32-ha) area. Therefore, construction of a facility for UO_2 storage would be considered a moderate adverse impact to wildlife.

Impacts to surface water and groundwater quality during construction are expected to be negligible (Section 6.3.4). Thus, construction derived impacts to aquatic biota would also be expected to be negligible.

Impacts due to construction of a facility to store UO_2 in vaults would be similar to impacts from storage in buildings, although a larger area would be affected. Facility construction would require the disturbance of approximately 114 acres (46 ha), including the permanent replacement of approximately 40 acres (16 ha) of current land cover with structures and paved areas. A larger proportion of the vault storage facility would be available for wildlife habitat in comparison with the building storage facility. However, species diversity and population densities would be expected to be low because of human presence, proximity of buildings, and the relatively low habitat quality of landscaped areas. Construction of a facility to store UO_2 in vaults would constitute a large adverse impact to vegetation and wildlife. The larger size of the facility would also increase the potential for unavoidable proximity to wetlands and consequent direct and indirect impacts. Impacts due to facility construction are shown in Table 6.18. Releases of contaminants are not expected to occur during operation of the vault storage facility, therefore, impacts to biotic resources due to facility operation would be negligible.

6.3.7 Waste Management

Impacts on waste management from wastes generated during the long-term storage of depleted UF_6 would be caused by the potential overload of waste treatment and/or disposal capabilities either at a site or on a regional or national scale.

6.3.7.1 Storage of UF_6 in Yards and Buildings

6.3.7.1.1 Yards

Construction of the storage pads and associated support facilities at the Portsmouth site would generate nonhazardous solid waste and sanitary wastewater. Construction would generate about 3,500 yd^3 (2,700 m^3) of concrete and other solid wastes. Because solid waste disposal facilities can generally be expanded as required, the impact of the construction wastes would be minimal at the site.

The operations to maintain and store depleted UF_6 cylinders at the site would consist of inspections, stripping and repainting of the external coating of cylinders, and disposal of scrap metal from old steel cylinders. These operations would generate three primary radioactive waste streams: uranium-contaminated scrap metal (LLW) from replaced cylinders, UO_2F_2 (LLW) from replaced cylinders, and solid process residue (LLMW) from cylinder painting. In addition, long-term yard storage operations would generate nonhazardous solid CaF_2 waste and sanitary wastewater. The amount of waste generated would depend upon the time when the activities occurred. For each waste type, the amount of waste generated annually would be larger during Phase I of the operations (see Table 6.19). The waste totals from Phase I were generally used for comparison with the site waste loads.

The 109 yd^3/yr (83 m^3/yr) of scrap metal LLW and the 0.17 yd^3/yr (0.13 m^3/yr) of UO_2F_2 generated during Phase I would add 1.8% to representative site LLW generation (Table 6.19). The maximum amount of LLW generated annually during the continued storage of depleted UF_6 at the site would represent less than 1% of the projected annual DOE LLW generation. The 46 yd^3/yr

TABLE 6.19 Estimated Annual Waste Loads from Long-Term Storage of UF_6 in Yards

	Waste Load of Depleted UF_6		
	Annual Load (m^3/yr)		Total Load (m^3)
Waste Type	2009–2028	2029–2039	2009–2039
Low-level waste			
Scrap metal	83	44	2,144
UO_2F_2	0.13	0.07	3.37
Low-level mixed waste (inorganic process residue)	8.8	35	561
Nonhazardous waste (CaF_2)	0.08	0.05	2.15
Sanitary wastewater	6,500	6,700	204,000

[a] NA = not applicable; NR = not reported.

Source: DOE (1997).

(35 m^3/yr) of LLMW generated during long-term yard storage of depleted UF_6 would add about 2% to the LLMW load at the site, and wastes from UF_6 storage would be less than 1% of the total nationwide LLMW load.

The 0.11 yd^3/yr (0.08 m^3/yr) of solid nonhazardous waste generated during Phase I would represent less than 1% of the annual waste loads at the site. The 8,700 yd^3/yr (6,700 m^3/yr) of sanitary wastewater would represent less than 1.5% of the annual wastewater load of the site.

Overall, the waste input resulting from the long-term yard storage of depleted UF_6 would have negligible impact on radioactive waste management capabilities at the Portsmouth site. The impact on nonradioactive site waste management would also be negligible. The impacts of waste resulting from the long-term yard storage of depleted UF_6 on national waste management capabilities would be negligible.

6.3.7.1.2 Buildings

The wastes generated during construction of any of the different types of storage facilities would be typical of a large construction project. The only wastes would be construction debris and the sanitary wastes of the labor force. Estimates for the wastewater generated during construction of the different types of UF_6 storage facilities are shown in Table 6.20.

TABLE 6.20 Estimated Total Wastewater Volumes from Construction of Long-Term Storage Facilities for UF_6, U_3O_8, and UO_2

Uranium Compound	Wastewater Volume (million L)		
	Buildings	Vaults	Yards
UF_6	4.0	NA[a]	24.0
U_3O_8	4.7	6.2	NA
O_2	2.1	2.7	NA

[a] NA = data not available.

Operation of the UF_6 storage facility would be divided into two phases. Phase I (2009–2028) would involve the receipt, inspection, and repackaging of the depleted uranium containers and relocation of these containers to the storage facility. The wastes generated during this operation would be sanitary wastes of the labor force and the empty containers from the repacking process.

Phase II operations (2029–2039) would involve cylinder inspection, removal, repackaging and replacing of damaged containers. Damaged cylinders were assumed to be LLW. Waste generated during this phase of operations would be sanitary wastes of the labor force and the empty failed cylinders. The conversion of "heels" of UF_6 in damaged cylinders would result in UO_2F_2 waste (LLW) and a CaF_2 waste. The wastes expected from the storage of UF_6 are listed in Table 6.21.

6.3.7.2 Storage of U_3O_8 and UO_2 in Buildings and Vaults

The discussion of waste generation during construction and operations given in Section 6.3.7.1.2 on storage of depleted UF_6 also applies to the storage of U_3O_8 and UO_2. Estimates of wastewater generation during construction of U_3O_8 and UO_2 long-term storage facilities are given in Table 6.20. Estimates of waste generation during storage of U_3O_8 and UO_2 are given in Table 6.21. No UO_2F_2 or CaF_2 wastes would be generated in the storing of these waste forms.

6.3.7.3 Summary

Overall, the LLW generated annually during the operation of the different types of storage facilities (yards, buildings or vaults) would be small (less than 1%) compared with the expected

TABLE 6.21 Annual Waste Loads from Long-Term Storage of UF_6, U_3O_8, and UO_2 in Buildings and Vaults

Time Period	Low-Level Waste (m^3/yr)	UO_2F_2 (LLW) (kg/yr)	CaF_2 (Nonhazardous) (kg/yr)	Wastewater (million L/yr)
Storage as UF_6				
Phase I				
Buildings	2.95	140	71	4.2
Vaults	NA[a]	NA	NA	NA
Phase II				
Buildings	0.2	8.8	4.4	3.4
Vaults	NA	NA	NA	NA
Storage as U_3O_8				
Phase I				
Buildings	1.05	NA	NA	4.4
Vaults	1.1	NA	NA	4.3
Phase II				
Buildings	0.05	NA	NA	3.4
Vaults	0.05	NA	NA	3.3
Storage as UO_2				
Phase I				
Buildings	0.75	NA	NA	4.0
Vaults	0.8	NA	NA	3.9
Phase II				
Buildings	0.04	NA	NA	3.1
Vaults	0.04	NA	NA	2.9

[a] NA = not applicable.

annual LLW generation at the Portsmouth site. The waste input resulting from the long-term storage of any of the three types of uranium forms would have minimal impact on radioactive waste management capabilities at the site. The impact on nonradioactive waste management would also be minimal. The impacts of waste resulting from the long-term storage of any of the final uranium forms on national waste management capabilities would be negligible.

6.3.8 Resource Requirements

The approach taken for assessment of resource requirements was based on a comparison of required resources with national and state-level statistics on consumption of commodities (U.S. Department of Commerce 1997, 1999). More detailed information relating to the methodology is presented in Appendix C of the PEIS.

Resource requirements include all materials necessary to construct and operate the storage facilities. The requirements discussed in this section are for the storage of the three chemical forms of depleted uranium. In general, the amount of resources is directly related to the magnitude of construction, with the least resources required for UF_6 storage in yards. Materials required could include concrete, sand, cement, and steel. In general, none of the construction resources identified are in short supply, and any impacts on the local economies would be small. No strategic and critical materials are projected to be consumed for either construction or operations phases.

Energy resources during construction and operations would include the consumption of diesel fuel and gasoline for construction equipment and transportation vehicles. The anticipated requirements would appear to be small and not impact local or national supplies.

During the operations phase, no chemicals are projected to be required. The amount of natural gas would be relatively small and would be expected to be readily available.

Estimated utilities and materials required for constructing storage facilities for UF_6, U_3O_8, and UO_2 are listed in Table 6.22 for the storage options. Estimated utilities and materials required for operating the storage facilities for UF_6, U_3O_8, and UO_2 are shown in Table 6.23. The resource requirements are presented separately for Phase I operations, which would be concurrent with the construction period, and for Phase II operations.

6.3.9 Land Use

Land area requirements for each uranium chemical form and relevant storage option are presented in Table 6.24. These data do not include acreage required for the construction phase for any of the storage options because development of land would be incremental and space required

TABLE 6.22 Resource Requirements for Constructing UF_6, U_3O_8, and UO_2 Storage Facilities

Utilities/Material	Total Consumption: Yards/ Vaults[a]	Buildings
UF_6 Storage Facility		
Utilities		
Electricity (MWyr)	0.40	5.4
Solids		
Concrete (m^3)	59,000	69,000
Cement (metric tons)	12,000	14,000
Macadam (m^3)	3,100	3,100
Steel (metric tons)	1,000	29,000
Liquids		
Diesel fuel (million L)	0.06	10
Gasoline (thousand L)	53	8.6
U_3O_8 Storage Facility		
Utilities		
Electricity (MWyr)	6.3	5.4
Solids		
Concrete (m^3)	82,000	110,000
Cement (metric tons)	16,000	22,000
Macadam (m^3)	3,400	12,000
Steel (metric tons)	34,000	37,000
Liquids		
Diesel fuel (million L)	12	150
Gasoline (thousand L)	11	11
UO_2 Storage Facility		
Utilities		
Electricity (MWyr)	3.0	2.5
Solids		
Concrete (m^3)	37,000	48,000
Cement (metric tons)	7,500	9,700
Macadam (m^3)	2,200	5,600
Steel (metric tons)	16,000	17,000
Liquids		
Diesel fuel (million L)	5.3	66
Gasoline (thousand L)	3.5	3.7

[a] UF_6 options include yards and buildings. U_3O_8 and UO_2 options include vaults and buildings.

Sources: LLNL (1997); Folga (1996d).

TABLE 6.23 Resource Requirements for Operating UF_6, U_3O_8, and UO_2 Storage Facilities

	Annual Requirement			
	Yards		Buildings	
Utilities/Material	Phase I	Phase II	Phase I	Phase II
UF_6 Storage Facility				
Electricity (MWh)	1,700	1,700	1,600	1,600
Natural gas (million scm)	0.31	0.31	0.31	0.31
Diesel fuel (thousand L)	57	60	52	0.02
Gasoline (thousand L)	1.7	2.4	10	8
U_3O_8 Storage Facility				
Electricity (MWh)	1,700	1,700	1,700	1,700
Natural gas (million scm)	0.35	0.38	0.10	0.10
Diesel fuel (thousand L)	65	0.02	120	0.04
Gasoline (thousand L)	13	8.5	13	10
UO_2 Storage Facility				
Electricity (MWh)	1,200	1,200	1,100	1,100
Natural gas (million scm)	0.21	0.21	0.10	0.10
Diesel fuel (thousand L)	39	0.01	93	0.04
Gasoline (thousand L)	8.0	5.7	8.5	6.3

Source: LLNL (1997).

TABLE 6.24 Land Requirements for the Long-Term Storage Options

	Land Requirement[a] (acres)		
Option	Yards	Buildings	Vaults
Storage as UF_6	144	131	NA[b]
Storage as U_3O_8	NA	148	212
Storage as UO_2	NA	79	114

[a] There is no distinction between construction and operations because the storage areas would be cleared incrementally on the basis of need. Consequently, the acreage requirements listed here are the total number of acres required to meet the capabilities of the option.

[b] NA = not applicable (option does not include this method of storage).

Source: LLNL (1997).

for material excavation storage, equipment staging, and construction material laydown areas would be available on adjacent undeveloped parcels. Consequently, areal needs for construction would not be greater than that for operations.

Selection of a storage facility location within the Portsmouth site that is already dedicated to similar use could result in reduced land use impacts because immediate access to infrastructure and utility support would be possible with only minor disturbances to existing land use.

6.3.9.1 Storage as UF_6

In general, impacts to land use from the construction and operation of facilities dedicated to storage of depleted uranium in a UF_6 chemical form would be negligible and limited to clearing of required land, potential minor and temporary disruptions to contiguous land parcels, and a slight increase in vehicular traffic.

A storage building option would require 131 acres (53 ha) of land, and the storage yard option would require 144 acres (58 ha). These areas represent about 4% of the Portsmouth site land.

The amount of land required for the storage as UF_6 options could result in potential land disturbance impacts, particularly if the site location featured land that was heavily wooded.

Road and rail access within a storage site, regardless of storage option, would be designed to minimize on-site traffic conflicts. For off-site traffic, potential impacts associated with construction vehicles could be encountered. The maximum labor force required for operation at a long-term storage facility, regardless of the storage option, would not be great enough to generate traffic impacts.

6.3.9.2 Storage as U_3O_8

Storage as U_3O_8 would require the greatest amount of land per option (see Table 6.24) and would result in the greatest amount (1,700,000 yd^3 [1,300,000 m^3]) of excavated material and rock spoils. Disposal of the excavation material could result in minor land-use impacts that range from temporary disruptions of local traffic to minor land modification at the disposal site. Areal requirements for storage as U_3O_8 would range from 148 to 212 acres (59 to 86 ha). Consequently, the potential for land disturbance impacts would be greater than that expected for storage as either UF_6 or UO_2.

Road and rail access within a storage site, regardless of storage option, would be designed to minimize on-site traffic conflicts. For off-site traffic, only temporary minor impacts associated with construction vehicles could be encountered. The maximum labor force required for operation, regardless of the storage option, would not be great enough to generate traffic impacts.

6.3.9.3 Storage as UO_2

Storage as UO_2 would require the least amount of land per option (see Table 6.24) and would result in the least amount (750,000 yd^3 [575,000 m^3]) of excavated material and rock spoils. Disposal of the excavation material could result in land-use impacts, but such impacts are expected to be negligible and of a lesser magnitude than would occur under storage as U_3O_8 or UF_6. Less land would have to be cleared for storage facilities (between 25 and 40 acres [10 and 16 ha]). Consequently, the potential for land disturbance impacts would be less than that expected for storage as either UF_6 or U_3O_8. The maximum labor force required for operations would not be great enough to generate off-site traffic impacts.

6.3.10 Other Impacts Considered But Not Analyzed in Detail

Other impacts that could potentially occur if the storage options considered in this PEIS were implemented include impacts to cultural resources and environmental justice, as well as impacts to the visual environment (e.g., aesthetics), recreational resources and noise levels, and impacts associated with decontamination and decommissioning of the storage facilities. These impacts, although considered, were not analyzed in detail for one or more of the following reasons:

- The impacts could not be determined at the programmatic level without consideration of specific locations for construction within the Portsmouth site, which are not currently known. These impacts would be more appropriately addressed in the second-tier NEPA documentation when specific locations are considered.

- Consideration of these impacts would not contribute to differentiation among the alternatives and therefore would not affect the decisions to be made in the ROD for the PEIS.

6.4 POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED WITH LONG-TERM STORAGE OF THE ENTIRE CYLINDER INVENTORY AT THE PORTSMOUTH SITE

After the draft PEIS was completed, management responsibility for approximately 11,200 additional cylinders of depleted UF_6 was transferred from USEC to DOE by the signing of two MOAs associated with the privatization of USEC (DOE and USEC 1998a,b). To account for uncertainties associated with the number of cylinders that would be transferred from USEC to DOE in the future and to provide a bounding analysis of environmental impacts, the final PEIS analyzed the environmental impacts of managing an additional 15,000 cylinders. These analyses are summarized in Chapter 6 of the depleted UF6 PEIS; impacts associated with long-term storage of the entire inventory (including USEC cylinders) at the Portsmouth site are summarized here in Section 6.4.

6.4.1 Approach Used to Evaluate the Environmental Impacts of Long-Term Storage for the Entire Cylinder Inventory

To account for the management of USEC-generated cylinders in the long-term storage options, the basic facility designs were assumed to remain the same, but the facilities were assumed to operate over a longer period of time. It was assumed that the period for operations would be extended by about 6 years to accommodate the additional USEC-generated cylinders (i.e., from 20 to 26 years). Under this assumption, annual impacts would generally remain the same as those reported on in Section 6.3, although the total impacts would generally increase by about 30%. Additionally, the land use requirements for the long-term storage options would be increased by about 30% to accommodate the additional inventory.

The assumption that operations at long-term storage facilities would be extended by 6 years did not change the basic analytical time frame used (i.e., 41 years, from 1998 through 2039). As a result of including the USEC cylinders, the time frame for operations (including emplacement of the entire inventory) at long-term storage facilities was assumed to be from the year 2009 through 2034; monitoring operations at long-term storage facilities were assumed to occur from 2035 through 2039. At a long-term storage facility, surveillance and maintenance requirements would be increased during the years of monitoring, for a total increase of about 30% for the surveillance and maintenance period of 2035 through 2039.

6.4.2 Potential Environmental Impacts from Long-Term Storage of the Entire Cylinder Inventory (DOE- and USEC-Generated Cylinders)

6.4.2.1 Human Health and Safety — Normal Operations

6.4.2.1.1 Workers

In general, the average annual radiation dose to individual workers associated with long-term storage of the additional USEC cylinders would be the same as that for DOE-generated cylinders reported on in Section 6.3.1 (i.e., well within applicable standards) because at long-term storage facilities, the annual worker activities would be the same, but the emplacement activities would be ongoing over a longer period of time. The total doses and numbers of LCFs for involved and noninvolved workers would be increased by about 30% (see values in brackets in Table 6.2).

For long-term storage options, the doses to noninvolved workers would remain negligible even with the addition of the USEC cylinders, as discussed in Section 6.3.1.1. Hazardous chemical exposure levels for noninvolved workers would remain negligible as discussed in Section 6.3.1.2.

6.4.2.1.2 General Public

For long-term storage options, the doses to members of the general public would remain negligible even with the addition of the USEC cylinders, as discussed in Section 6.3.1.1. No chemical impacts to the general public would be associated with the increased cylinder inventory.

6.4.2.2 Human Health and Safety — Accident Conditions

6.4.2.2.1 Physical Hazards

The total number of worker fatalities and injuries associated with long-term storage options would increase by about 30% with the addition of the USEC cylinders (see values in brackets in Table 6.2).

6.4.2.2.2 Accidents Involving Releases of Radiation or Chemicals

For accident consequences, impacts would be the same as those previously discussed for the DOE-generated cylinders (Section 6.3.2), because the types of accidents assessed would involve only a limited amount of material that would be at risk under accident conditions. Although the estimated frequencies of some accidents would increase somewhat in association with the additional USEC-generated cylinders, this increase is not expected to be enough to change the overall expected frequency of specific accidents from the broad ranges used in the PEIS.

6.4.2.3 Air Quality

At a consolidated long-term storage facility, impacts on criteria pollutant emissions from construction and operation would be the same as those for DOE-generated cylinders discussed in Section 6.3.3. The air quality impacts would be the same because, although the size of the long-term storage facility would increase by about 30% as a result of the addition of the USEC-generated cylinders, the annual level of operations (and emissions) would remain unchanged. No emission of uranium compounds was predicted in association with long-term storage options.

6.4.2.4 Water and Soil

Because the duration of construction and operational activities at a long-term storage facility would be increased by 6 years, from 2 to 38 million gal of additional water would be required for construction, and about 7 to 8 million gal of additional water would be required for operations. About 6 to 8 million gal of additional wastewater would be generated. The total amount of water required during construction would range from about 8 to 170 million gal; the total amount of water used during operations would be about 29 to 36 million gal; the total wastewater generated would be about 26 to 34 million gal.

Impacts to surface water and groundwater from long-term storage facilities would partially depend on the actual location within the Paducah site. Because total overall discharges would be extremely small (see Section 6.3.4), no impacts to groundwater quality from the additional USEC-generated cylinders would be expected at a consolidated long-term storage facility.

The addition of USEC-generated cylinders would increase excavation requirements for a long-term storage facility. The additional excavation volumes would range from 25 to 35% for the various options. The total required excavation volumes would range from 323,000 yd^3 (250,000 m^3) for the storage as UF_6 in yards option to 2.3 million yd^3 (1.8 million m^3) for the storage as U_3O_8 in vaults option.

6.4.2.5 Socioeconomics

Construction and operation of a long-term storage facility would be extended by 6 years as a result of the addition of the USEC-generated cylinders. The peak year construction costs would not change. For operations, the emplacement period, originally assumed to extend from the year 2009 through 2028, would be extended through 2034, with the surveillance and maintenance period being reduced to the years 2035 through 2039. The average annual income and number of jobs estimated for the surveillance and maintenance period would increase by about 30% as a result of the addition of the USEC-generated cylinders. To estimate the change in socioeconomic impacts associated with the additional USEC cylinders, 30% of the average annual number of jobs and income during the surveillance and maintenance period for each option were added to the average annual number of jobs and income during the emplacement period from 2009 through 2028 (Allison and Folga 1997). Adding this increased the range for the number of annual direct jobs by 11–15 for the long-term storage options, resulting in a total range of 60 to 80 direct jobs when both DOE- and USEC-generated cylinders are considered. Correspondingly, annual direct income would increase by about $1 million, to a total of $4 to 5 million.

6.4.2.6 Ecology

At a long-term storage facility, storage as UF_6 would increase land use by 11 to 26 acres (4 to 10 ha), storage as U_3O_8 would increase land use by 14 to 52 acres (6 to 21 ha), and storage as UO_2 would increase land use by 7 to 22 acres (3 to 9 ha). These increases would result in additional habitat loss. The total land required for long-term storage would be about 170 acres (68 ha) for storage as UF_6, from about 170 to 260 acres (68 to 106 ha) for storage as U_3O_8, and from about 90 to 135 acres (36 to 54 ha) for storage as UO_2. These total land requirements would have a moderate to large potential impact on vegetation and wildlife.

6.4.2.7 Waste Management

For the operation and construction of a consolidated long-term storage facility, the addition of the USEC cylinders would generate an additional 26 or 900 yd^3 (20 m^3 or 690 m^3) of LLW for storage as UF_6 in buildings or yards, respectively, for the period 2009 through 2039. For UO_2 and U_3O_8, an additional 7 or 9 yd^3 (5 or 7 m^3) of additional LLW, respectively, would be generated for either the building or vault options. For the entire inventory over the entire period of construction and operations, the total amount of LLW generated from long-term storage options would range from about 26 to 3,700 yd^3 (20 to 2,800 m^3). Impacts to site and national waste management capabilities from of this amount of LLW would be negligible.

6.4.2.8 Resource Requirements

In general, the addition of the USEC cylinders would not change the impact assessment for resource requirements for conversion activities. The construction requirements identified in Section 6.3.8 would remain the same. The annual resource requirements for construction and Phase I operations identified in Tables 6.22 and 6.23 would be extended for an additional 6 years; the Phase II requirements identified in Table 6.23 would increase by about 30%, but the period of Phase II operations would decrease by 6 years. No significant impacts would be expected, because construction and operational requirements would not be resource intensive, and the resources required would not be rare or unique.

6.4.2.9 Land Use

At a long-term storage facility, storage as UF_6 would increase land use by 11 to 26 acres (4 to 10 ha), storage as U_3O_8 would increase land use by 14 to 52 acres (6 to 21 ha), and storage as UO_2 would increase land use by 7 to 22 acres (3 to 9 ha). The total land required for long-term storage would be about 170 acres (68 ha) for storage as UF_6, from about 170 to 260 acres (68 to 106 ha) for storage as U_3O_8, and from about 90 to 135 acres (36 to 54 ha) for storage as constituting a moderate to large potential land use impact.

6.4.2.10 Cultural Resources

Impacts to cultural resources from a long-term storage facility at the Paducah site cannot be determined at this time and would depend on the exact location within the site and whether eligible cultural resources existed on or near that location.

6.4.2.11 Environmental Justice

Potential environmental justice impacts to minority and low-income populations from the construction and operation of long-term storage facilities would depend on the locations of these facilities within the Paducah site. Although these specific locations are not known, no disproportionately high and adverse effects to minority or low-income populations would be expected in the vicinity of the Paducah site in association with the long-term storage of the entire cylinder inventory (DOE- and USEC-generated cylinders), because impacts from long-term storage activities did not exceed the screening criteria for adverse impacts outlined in Section C.8.2.3 of the PEIS.

7 CUMULATIVE IMPACTS AT THE PORTSMOUTH SITE

Cumulative impacts are those impacts that result from the incremental impact of an action (in this case, depleted UF_6 management) when added to the impacts of other past, present, and reasonably foreseeable future actions. To conduct the cumulative impacts analysis for the PEIS, DOE examined those impacts associated with depleted UF_6 management activities certain to occur at the Portsmouth site under all alternatives, which include continued cylinder storage for some period for all alternatives and cylinder preparation for shipment for all alternatives except the no action alternative. To these impacts, DOE then added the impacts of other past, present, and reasonably foreseeable future actions in order to assess cumulative impacts. The USEC actions related to enrichment activities were included as a continuation of past DOE actions at the Portsmouth site. Non-DOE actions were considered when they would occur at the Portsmouth site, or when the nature of their impacts at a location near the site could increase impacts anticipated at the site. At the time of preparation of the PEIS, locations for conversion and long-term storage activities were not known, so these activities were not included in the cumulative impacts analysis. Since this cumulative impacts summary is based on the PEIS, these activities are also not included here.

7.1 CUMULATIVE IMPACT ISSUES AND ASSUMPTIONS

The cumulative impact analysis considered the following impact areas for existing operations, depleted UF_6 management options, and other reasonably foreseeable future actions:

- ***Health Risk***

  - Collective radiation dose and cancer risk for the general public over the 41-year period of depleted UF_6 operations,

  - Annual radiation dose for a hypothetical maximally exposed off-site individual,

  - Collective radiation dose and cancer risk for the worker population, and

  - Number of truck or rail shipments of radioactive materials to and from the site and the contributions to the dose to an MEI near the site gate;

- ***Environmental Quality***

  - Potential emissions that affect air quality compared to air quality standards and

- Potential contaminants that affect groundwater quality concentrations compared to drinking water standards or other guideline values;

- ***Resource and Infrastructure Requirements***

  - Land requirements (presented as the percent of suitable land at the site occupied by existing facilities and needed for depleted UF_6 management activities and other future actions),

  - Percent of current water supply (presented as the percent of existing capacity needed for existing operations, depleted UF_6 management activities, and other future actions),

  - Percent of current wastewater treatment capacity (presented as the percent of existing capacity needed for existing operations, depleted UF_6 management activities, and other future actions), and

  - Percent of current power capacity (presented as the percent of existing capacity needed for existing operations, depleted UF_6 management activities, and other future actions).

The health risks to the off-site population are reported as collective exposures and risks for the entire period of conducting a particular operation, while the dose to the maximally exposed individual is reported as an annual value. Annual exposures are used for the maximally exposed individual to allow a direct comparison to the DOE maximum dose limit of 100 mrem/yr exposure to an individual of the general public (MEI) from all radiation sources and exposure pathways (DOE Order 5400.5). A cumulative impacts table containing the impact categories and the major elements composing the cumulative impacts is presented for the Portsmouth site. These elements include the existing conditions at the site, the maximum impacts of depleted UF_6 management activities analyzed in the PEIS, and the impacts of other reasonably foreseeable future actions.

The impact categories addressed as part of the cumulative impact analysis for the site are those associated with depleted UF_6 management that might generate noteworthy environmental effects when aggregated with the environmental consequences of other actions. Some impacts, such as impacts to ecological resources and cultural resources, were not included in the cumulative impact analysis because they are dependent on the specific facility location within the site boundary and location-specific environmental factors. Other impacts, such as impacts of accidents, were not included because it is highly improbable that accidents would occur together.

Cumulative impacts for the Portsmouth site were evaluated by adding the impacts of depleted UF_6 management options to the impacts of past, present, and reasonably foreseeable future actions at the site and in the region (primarily actions that DOE is considering for other programs). The latter include actions related to production and management of nuclear materials, management of nuclear fuel, research and development activities, and defense programs. To assess the effects of cumulative impacts, the estimated cumulative impacts calculated for the site were compared to regulatory levels for MEI exposures, air quality standards, and drinking water standards or guidelines for these parameters. If regulatory levels or guidelines would be exceeded, then the impact could be considered significant. LCFs among the public would be considered significant if the cumulative impacts of activities at the site would yield more than 1 LCF over the 41-year period. Because radiological exposure of workers would be maintained at or below regulatory levels, resulting LCFs to those individuals would be those corresponding to acceptable radiation doses. Resources and infrastructure impacts would be considered significant if the land area required, water use, wastewater production, or power demand approached 100% of capacity for the site.

Cumulative impacts also included the consequences of recent and current environmental restoration actions. The impacts of future environmental restoration actions at the site were not included in the cumulative impact analysis because of insufficient characterization of the contamination and because proposals for particular actions are not yet final. Impacts of future environmental restoration activities at the sites would be analyzed in later site-specific CERCLA/RCRA program documents.

Past impacts included in the cumulative impact analysis consist of past construction, development, and environmental restoration activities that contributed to existing conditions at the site and any past activities that may have resulted in current groundwater contamination at the site; these are presented as impacts of existing operations.

No assumptions are made regarding future baseline conditions at the site that could potentially reduce impacts, such as cessation of certain ongoing operations that would reduce current levels of radioactive releases. A number of other simplifying assumptions were made to estimate cumulative impacts regarding timing, site location, and consistency of analytical methods. Other existing or planned actions at the site were assumed to occur during the period of depleted UF_6 management operations. These other actions were assumed to be collocated with depleted UF_6 management facilities to the extent that they affect the same off-site population and MEI. These assumptions result in conservative analyses that overestimate actual cumulative impacts.

Some or most of the depleted UF_6 cylinder management activities currently occurring at the site (and considered under existing operations) would persist during continued storage and are included in the impacts of continued storage. When estimating cumulative impacts over the 41-year assessment period, no adjustment was made for this overlap. This adds to the conservatism in the calculated cumulative collective population impacts for both the workers and members of the general public at the site.

The above simplifying assumptions could result in some differences in the estimated cumulative impacts between this report and other site-specific documents. In addition, these simplifying assumptions and other assumptions used in performing calculations can result in some uncertainty regarding projected cumulative impacts. This cumulative impact analysis should be used only as a starting point for analyzing site-specific cylinder management program activities at the Portsmouth site; any future site-specific NEPA analysis would supersede this cumulative analysis.

7.2 IMPACTS OF CONTINUED CYLINDER STORAGE AND PREPARATION

This analysis focuses on potential cumulative impacts at the site from continued storage and cylinder preparation. For purposes of analysis, the maximum impacts estimated at the site for continued cylinder storage and cylinder preparation activities from any of the PEIS alternatives were used to provide an upper estimate of potential cumulative impacts.

Actions planned at the Portsmouth site include the continuation of existing operations, waste management activities, environmental restoration activities, and the depleted UF_6 management activities addressed in the PEIS. Table 7.1 identifies the projected cumulative impacts that could result from future depleted UF_6 management activities and current activities at Portsmouth. As identified in the table, the maximum annual radioactive releases associated with depleted UF_6 management activities would result in a very slight increase in the radiation dose to the off-site population. However, cumulative radioactive releases would still be considerably below the DOE dose limit of 100 mrem/yr to the off-site MEI.

The depleted UF_6 management activities would be unlikely to result in any additional land disturbance at Portsmouth because all activities are expected to occur on currently developed land. On-site infrastructure demands for water, wastewater treatment, and power would increase by at most very small amounts due to depleted UF_6 management activities. Cumulative requirements would remain well within existing capacities.

The Portsmouth site is located in an attainment region where criteria air pollutants do not currently exceed regulatory standards. During construction activities at the site for continued storage or cylinder preparation, pollutant concentrations at the facility boundary would generally not exceed applicable air quality standards or guidelines. If short-term concentrations of fugitive dust emissions (PM_{10}) approached air quality standards during construction, these impacts would be temporary and could be minimized by good engineering and construction practices and standard dust suppression methods.

On the basis of data from 1996 annual groundwater monitoring, 11 pollutants have been found to exceed primary drinking water regulation levels in groundwater at the Portsmouth site: chromium, uranium, chloroform, cis-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,-dichloroethene, Freon-113, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride (LMES 1997d). Elevated levels of technetium-99 have also been detected in groundwater.

TABLE 7.1 Cumulative Impacts of Depleted UF_6 Activities, Existing Operations, and Other Reasonably Foreseeable Future Actions at the Portsmouth Site, 1999 through 2039

Impact Category	Impacts of Existing Operations[a]	Maximum Impacts of Depleted UF_6 Management Activities: Continued Storage[b]	Maximum Impacts of Depleted UF_6 Management Activities: Cylinder Preparation	Impacts of Other Reasonably Foreseeable Future Actions[c]	Cumulative Impacts[d]
Off-site population					
Collective dose, 41 years (person-rem)	1.2	0.05	0.001	0.0054	1.3
Number of LCFs[e]	0.001	0.00002	6.0×10^{-7}	2.7×10^{-6}	6.3×10^{-4}
Annual dose to off-site MEI[f] (mrem)	0.066	0.02	4.5×10^{-5}	6.8×10^{-5}	0.069
Worker population					
Collective dose, 41 years (person-rem)	7,000	380	690	14.6	8,085
Number of LCFs[g]	2.80	0.16	0.28	0.0058	3.2
Transportation[h]					
Number of truck shipments, 41 years	10,660	–	13,421	34,090	58,171
Number of rail shipments, 41 years	8,815	–	3,356	13,000	25,171
Annual dose to MEI from truck (mrem)	1.04	–	0.0036	0.055	1.10
Annual dose to MEI from rail (mrem)	0.86	–	0.0025	0.021	0.88
Resources and infrastructure					
Land area (% of site)	21.6	0.0	0.6	0.34	22.5
Water use (% capacity)	36.8	0.07	0.07	0.06	37.0
Wastewater production (% capacity)	81.1	0.0	0.0	0.65	81.8
Power demand (% capacity)	79.2	0.0	0.06	0.11	79.4
Air quality[i]	None	None	None	None	None
Groundwater quality[j]	12 parameters[k]	None	None	None	12 parameters[k]

[a] Includes impacts of current UF_6 generation and management activities, waste management activities, environmental restoration activities that have proceeded to a point where their consequences can be defined (Peter Kiewit landfill, X-611A lime salvage lagoons, X-749/X-120 interim action, X-705A/B soil removal action, sitewide drainage ditches), and the components of the experimental Technology Applications Program applied at the Portsmouth site (X-231B oil biodegradation plot technology demonstration field tests, X-701B in situ chemical oxidation, X-701B surfactant studies, X-623 inorganic photo catalytic membrane treatment study, X-231A soil fracturing demonstrations, X-625 passive groundwater treatment through reactive media, in situ radiological decontamination demonstration in X-326, TechXtract™ surface decontamination process) (Bechtel Jacobs Company LLC 1998).

[b] The greater of either: (1) impacts from 41 years of continued storage under the No Action Alternative or (2) impacts from 20 years of continued storage under the Action Alternatives.

[c] Includes impacts related to the preferred alternative to waste management at the Portsmouth site (DOE 1997).

[d] Cumulative impacts equal the sum of the impacts of existing operations, depleted UF_6 management options, and other reasonably foreseeable future actions.

[e] Assumes 0.0005 LCF/person-rem.

[f] Based on LMES (1996), which contains releases for the year 1994. Cumulative impacts assume all facilities operate simultaneously and are located at the same point.

[g] Includes both facility and noninvolved workers. Assumes 0.0004 LCF/person-rem.

[h] The number of truck and rail shipments of radioactive materials. The MEIs (at gate) for truck and rail shipments were assumed to be different.

[I] Impacts indicate which emissions would result in nonattainment.

[j] Impacts of depleted UF_6 management activities, environmental restoration activities, or other future actions indicate whether water quality could be affected in the future.

[k] Chloroform, chromium, cis-1,2-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, Freon-113, technetium-99, 1,1,1-trichloroethane, trichloroethylene, uranium, and vinyl chloride.

Sources: LMES (1996, 1997), DOE (1997), and Bechtel Jacobs Company LLC (1998).

During continued storage of depleted UF_6, releases from breached cylinders could result in increased concentrations of uranium in the groundwater. If current cylinder maintenance programs control continued cylinder corrosion, the groundwater analysis indicates that the maximum uranium concentration in groundwater (from cylinder breaches) would be 5 :g/L, considerably below the guideline level used for comparison, 20 :g/L (EPA 1996). If no credit is taken for reduced cylinder corrosion rates from painting and maintenance, cylinders would have to undergo uncontrolled corrosion until about 2050 before groundwater concentrations of uranium would approach 20 :g/L in the future. The groundwater concentration would not actually reach 20 :g/L until later than the year 2100.

8 PARAMETRIC ANALYSIS: ENVIRONMENTAL IMPACTS OF CONVERSION AND LONG-TERM STORAGE OPTIONS FOR PROCESSING LESS THAN THE TOTAL DEPLETED UF_6 INVENTORY AT THE PORTSMOUTH SITE

The environmental impacts presented in the PEIS were based on the assumption that all facilities would be designed to either convert, store, manufacture and use, or dispose of all of the depleted UF_6 in the DOE inventory. This approach provided a conservative estimate of the impacts that could result from each of the alternatives considered. Detailed discussions of the estimated environmental impacts from processing the entire depleted UF_6 inventory are presented for cylinder preparation, conversion, long-term storage, manufacture and use, disposal, and transportation options in Appendices E through J of the PEIS, respectively. The results of these evaluations are referred to as "100%" cases because they are based on the assumption that all of the depleted UF_6 would be processed (i.e., converted, stored, manufactured and used, disposed of, or transported).

In contrast to the 100% cases, the parametric analysis cases presented in this chapter considered the environmental impacts of each option category if conversion and long-term storage facilities were designed to process or accommodate only a fraction of the depleted UF_6 inventory. The intent of the parametric analysis was to show how the environmental impacts calculated for the 100% cases would be affected by reductions in facility size and throughput. "Throughput" is a general term that refers to the amount of material handled or processed by a facility in a year. Sections 8.2 and 8.3 present the environmental impacts for the conversion and long-term storage options for facilities designed to process between 25% and 100% of the depleted UF_6 inventory at the Portsmouth site. In the PEIS, these were the only management activities analyzed by using data for the Portsmouth site, so these are the available results presented in this section.

For assessment purposes, the parametric analysis assumed that all facilities would be designed to operate over a 20-year time period (i.e., the period required to process the DOE-generated cylinders, similar to the 100% cases presented in Appendices E through J of the PEIS). Thus, it was assumed that the processing of only a fraction of the DOE depleted UF_6 inventory would be accomplished by building and operating smaller facilities than those required for the 100% cases. In practice, it would be possible to process a fraction of the inventory by operating facilities designed to process 100% of the inventory over 20 years for a reduced time period, such as 10 years, or by operating the facility at a reduced level. In addition, changes in operating schedule could be used to accommodate small changes in the DOE inventory. For example, a 10% increase in the total DOE inventory could be accommodated by operating a full-scale facility for 22 years instead of 20.

For a given option, the environmental impacts resulting from the parametric analysis cases would tend to be less than or equal to those presented for the 100% cases. Thus, if the impacts were negligible for the 100% case, the impacts for the parametric cases would also be negligible. For most areas considered — such as human health and safety during normal operations, water, ecology, resource requirements, waste management, land use, and socioeconomics — the impacts would decrease as the facility size or throughput decreased. However, the reduction in impacts would not always be proportional to the reduction in throughput. For example, a facility designed to process 500 cylinders per year would generally have smaller impacts than a facility designed to process 1,000 cylinders per year, although the impacts would not necessarily be half of those of the larger facility. For accidents producing the greatest consequences, impacts would tend to be the same for the parametric analysis cases and the 100% case, primarily because these types of accidents would involve only a limited amount of material that would be at risk under accident conditions regardless of the facility size or throughput.

The following sections summarize the approach and results of the parametric analysis. Section 8.1 presents a short summary of the assessment approach. The results are presented for the conversion options in Section 8.2 and for long-term storage options in Section 8.3. The discussion in this chapter does not include details of the assessment methodologies or definitions of the options considered in the PEIS. A detailed description of methodologies is presented in Appendix C of the PEIS. Definitions and descriptions of the option categories are provided in Sections 5 and 6 of this report.

8.1 PARAMETRIC ANALYSIS ASSESSMENT APPROACH

Two parametric cases were analyzed for conversion and long-term storage as oxide: (1) facilities designed to process or accommodate 50% of the depleted UF_6 inventory and (2) facilities designed to process or accommodate 25% of the inventory. To simplify the analysis, the parametric cases were analyzed in detail for a subset of options within each option category, as summarized in Table 8.1. A subset of options was selected because the relationships among the options within each category could be determined from the detailed analyses conducted for the 100% cases. Therefore, the results for the options analyzed in detail were used to estimate the impacts for all options within each category by comparison with the 100% cases.

The basic assessment approach, areas of impact, and methodologies used to evaluate the parametric cases were the same as those used to evaluate the 100% cases. The environmental impacts for the 100% cases were evaluated using information provided in the engineering analysis report (LLNL 1997), including descriptions of facility layouts; resource requirements; estimates of effluents, wastes, and emissions; and descriptions of potential accident scenarios. To support the parametric assessment, similar design information was used for facilities sized to process or accommodate 25% and 50% of the depleted UF_6 inventory (LLNL 1997).

The results of the parametric analysis are presented, where appropriate, as curves that show the environmental impacts as a function of facility throughput. The curves were constructed using the results for the 25%, 50%, and 100% cases. These curves can be used to estimate the environmental impacts for throughputs ranging between 25% and 100% of the depleted UF_6 inventory. In addition, the curves can also be used to provide rough estimates of the impacts for throughputs slightly below 25% and slightly above 100%. In cases where the impacts for the 100% case were

TABLE 8.1 Specific Options and Parametric Cases Analyzed in Detail for the Portsmouth Site

Option Category/ Options Analyzed in Detail	Parametric Cases Analyzed for Each Option
Conversion	Conversion to U_3O_8, UO_2, and metal:
	100% case: Conversion of 100% of the inventory over 20 years
	50% case: Conversion of 50% of the inventory over 20 years
	25% case: Conversion of 25% of the inventory over 20 years
Long-term storage	
Storage as UF_6 in buildings	Storage as UF_6:
	100% case: Storage of 46,422 cylinders
	50% case: Storage of 23,211 cylinders
	25% case: Storage of 11,606 cylinders
Storage as UO_2 in buildings	Storage as UO_2:
	100% case: Storage of 420,000 drums
	50% case: Storage of 210,000 drums
	25% case: Storage of 105,000 drums

negligible, the parametric analysis was conducted to confirm that the impacts were also negligible, and only a brief discussion is provided. (The terms used in the PEIS to describe impacts, such as "negligible," are defined in Chapter 4, Table 4.2, of the PEIS.)

8.2 CONVERSION OPTIONS

The parametric analysis of the conversion options considered the environmental impacts of converting 25% and 50% of the depleted UF_6 inventory to U_3O_8, UO_2, or uranium metal over a 20-year period. The assessment considered the environmental impacts that would occur during (1) construction of a conversion facility, (2) routine conversion facility operations, and (3) potential conversion facility accidents. The areas of impact and the methodologies used to evaluate the parametric cases were the same as those used to evaluate the 100% cases, the results of which are discussed in Section 5. The supporting data for the 25% and 50% parametric conversion cases are provided in the engineering analysis report (LLNL 1997).

In general, the impacts for the 100% cases are presented in Section 5 as ranges, resulting from differences in technologies within each option. For the purposes of the parametric analysis in the PEIS, one technology from each option was considered and evaluated in detail for one of the representative sites (i.e., Paducah, Portsmouth, or K-25). A single technology and a single site were evaluated for each option to simplify the parametric analysis. This simplification was possible because all technologies were evaluated at all representative sites for the 100% base case. The specific technologies considered were defluorination with anhydrous HF production for conversion to U_3O_8; dry defluorination with anhydrous HF production for conversion to UO_2; and continuous metallothermic reduction for conversion to uranium metal. The resulting relationships between the technologies and sites that were identified for the 100% case were used to infer ranges of impacts for the parametric cases examined in detail. Therefore, although not all PEIS parametric analyses were conducted specifically for the Portsmouth site, the impacts could generally be interpolated to estimate impacts for Portsmouth.

8.2.1 Human Health — Normal Operations

8.2.1.1 Radiological Impacts

The estimated radiological impacts — radiation doses and latent cancer fatalities (LCFs) — from the normal operation of a full-scale (100%) facility for converting depleted UF_6 to U_3O_8 are described in Appendix F, Section F.3.1.1, of the PEIS. Similar impacts were calculated for the 50% and 25% conversion facilities for the parametric analysis. The radiological impacts estimated for the 100%, 50%, and 25% case are shown in Figures 8.1 through 8.6 as the radiation doses for the six receptor scenarios considered in the PEIS:

- Members of the general public
  - Annual collective dose
  - Annual dose to the MEI

- Noninvolved workers
  - Annual collective dose
  - Annual dose to the MEI

- Involved workers
  - Annual collective dose
  - Annual average individual dose

The ranges of impacts resulting from technology differences for each option are represented by dashed lines in the figures. The results for the technology selected for detailed analysis are shown in the figures as solid points, with a curve drawn between the points to indicate how the impacts vary as a function of the percent of depleted UF_6 processed. The upper and lower bounds for impacts for the 25% and 50% cases were estimated on the basis of the range determined for the 100% case. The area enclosed by the lines in each figure indicates the range of impacts expected for throughputs between 25% and 100%, taking into account technology differences.

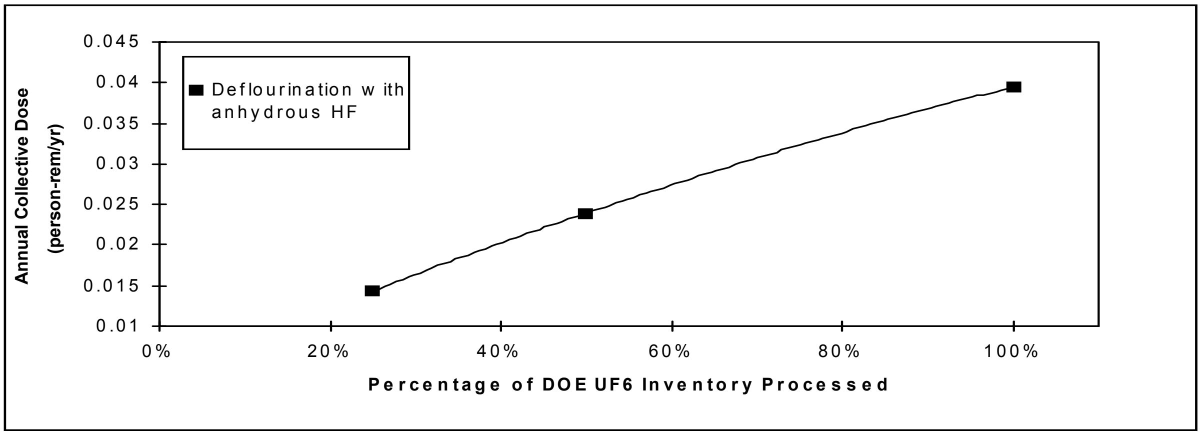

FIGURE 8.1 Estimated Annual Collective Dose to Members of the Public from the Conversion of UF_6 to U_3O_8 (No range is presented because the estimated collective doses were almost identical for the different conversion technologies.)

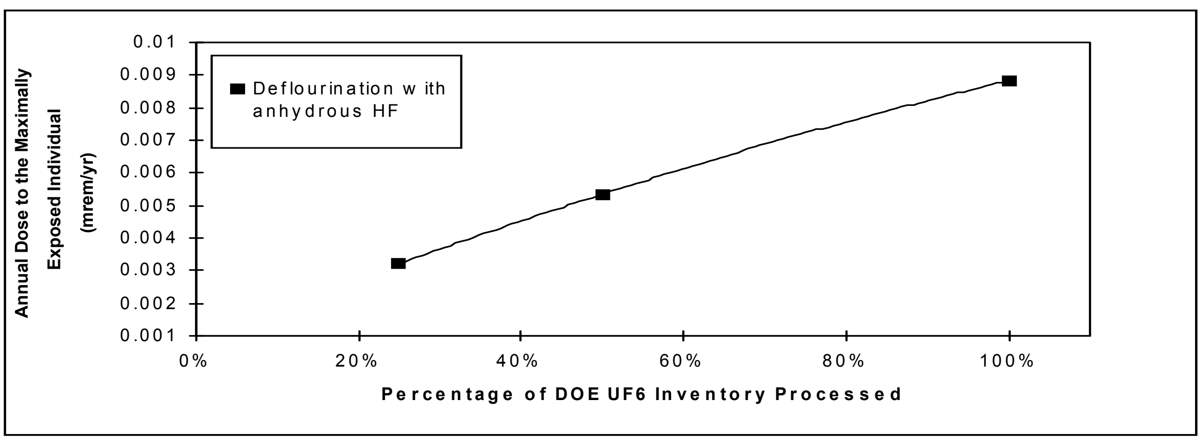

FIGURE 8.2 Estimated Annual Dose to the General Public MEI from the Conversion of UF_6 to U_3O_8 (No range is presented because the estimated MEI doses were almost identical for the different conversion technologies.)

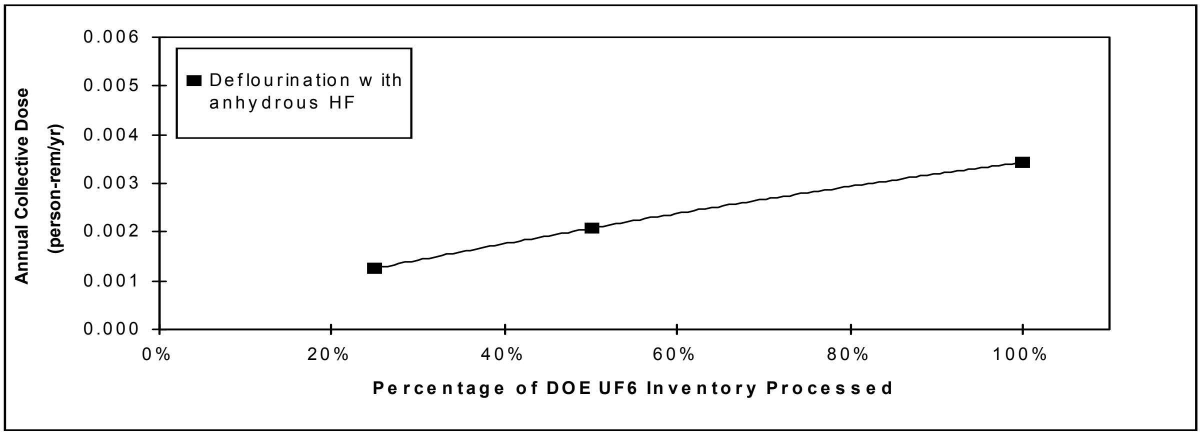

FIGURE 8.3 Estimated Annual Collective Dose to Noninvolved Workers from the Conversion of UF_6 to U_3O_8 (No range is presented because the estimated doses were almost identical for the different conversion technologies.)

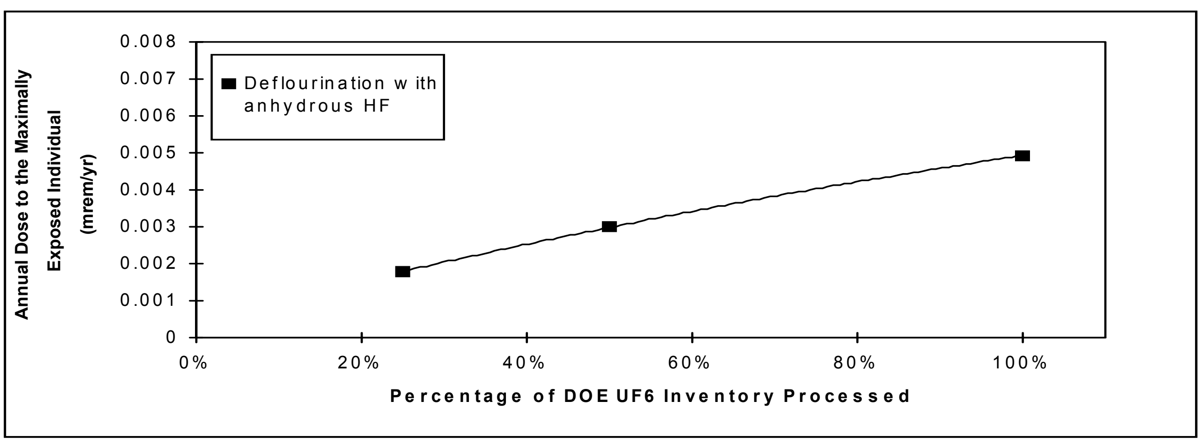

FIGURE 8.4 Estimated Annual Dose to the Noninvolved Worker MEI from the Conversion of UF_6 to U_3O_8 (No range is presented because the estimated collective doses to the MEI were almost identical for the different conversion technologies.)

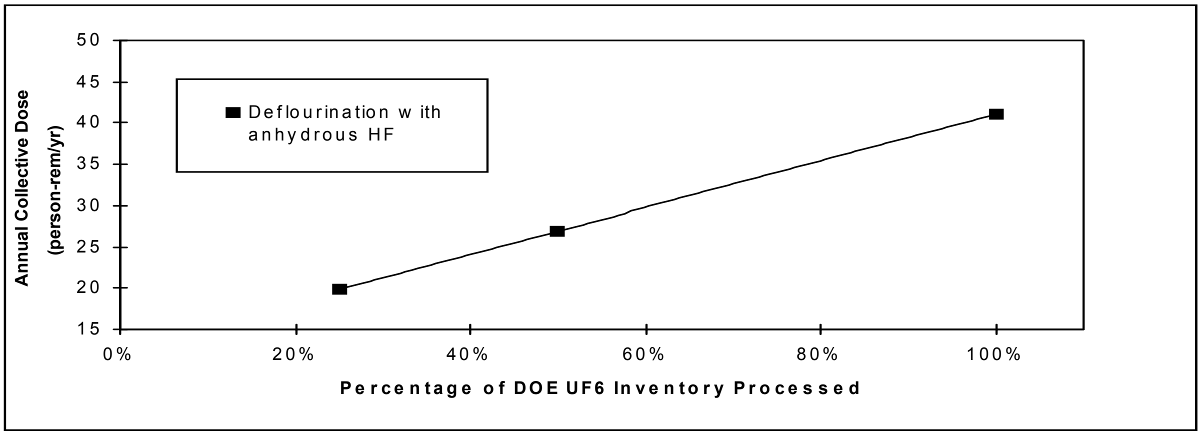

FIGURE 8.5 Estimated Annual Collective Dose to Involved Workers from the Conversion of UF_6 to U_3O_8 (No range is presented because the estimated collective doses to involved workers were almost identical for the different conversion technologies.)

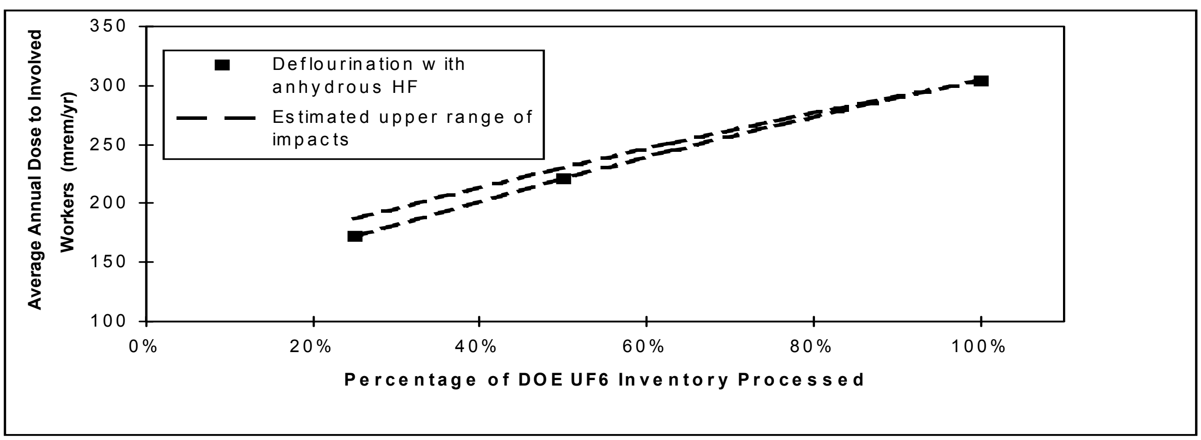

FIGURE 8.6 Estimated Annual Average Individual Dose to Involved Workers from the Conversion of UF_6 to U_3O_8 (The upper and lower ranges reflect differences in conversion technologies.)

The results of the parametric analysis for conversion to U_3O_8 (as shown in Figures 8.1 through 8.6) indicate that the radiological impacts would scale relatively linearly with the quantity of depleted UF_6 processed annually. The impacts of the 25% and 50% cases would be smaller than those for the 100% case, although the decrease would not be proportional to the reduction in throughput (i.e., the impacts for the 50% case would be greater than half of the impacts for the 100% case). The radiation doses to the general public would be greater than those to noninvolved workers because of longer exposure times and, for the collective dose, larger population size. The doses shown in the figures can be converted to the number (or risk) of LCFs by multiplying the doses (in rem or person-rem) by 0.0005 LCF/person-rem for members of the public and 0.0004 LCF/person-rem for workers. Additional discussion of the significance of the estimated doses is provided in Chapter 5.

For conversion to UO_2, the estimated radiation doses for the 100%, 50%, and 25% throughput cases are presented in Figures 8.7 through 8.12 for each of the six receptor scenarios considered in the PEIS. The results are presented in a manner similar to the results discussed previously for conversion to U_3O_8. The general relationship between radiological impacts and throughput for conversion to UO_2 is similar to that for conversion to U_3O_8; that is, the radiological impacts would decrease with decreasing throughput. The estimated radiological impacts (doses and LCFs) from normal operation of a full-scale (100%) facility for converting depleted UF_6 to UO_2 are described in Section 5.3.1.1.

For conversion to metal, the estimated radiation doses for the 100%, 50%, and 25% throughput cases are presented in Figures 8.13 through 8.18 for each of the six receptor scenarios considered in the PEIS. Similar to conversion to U_3O_8 and UO_2, the radiological impacts from conversion to metal would decrease with decreasing throughput. The estimated radiological impacts (doses and LCFs) from the normal operation of a full-scale (100%) facility for converting depleted UF_6 to uranium metal are described in Section 5.3.1.1.

The estimated radiological impacts from operation of the cylinder treatment facility are less than the impacts from the operations of the conversion facilities. Low-level exposures would be expected for involved workers and negligible exposures for noninvolved workers and the general public. The estimated radiation doses for the 100%, 50%, and 25% throughput cases are presented in Figures 8.19 through 8.24 for each of the six receptor scenarios considered in the PEIS.

Detailed numerical results for each of the parametric analyses can be found in the tables and on the disks of Cheng et al. (1997). For radiation exposure of the involved workers, the results are presented in Table 5.1 of Cheng et al. (1997) and on disk 3 under the file name conv-tm.xls. For the noninvolved workers and the general public, potential impacts resulting from airborne emission of uranium can be found on disk 1 under the file name airimpct.xls.

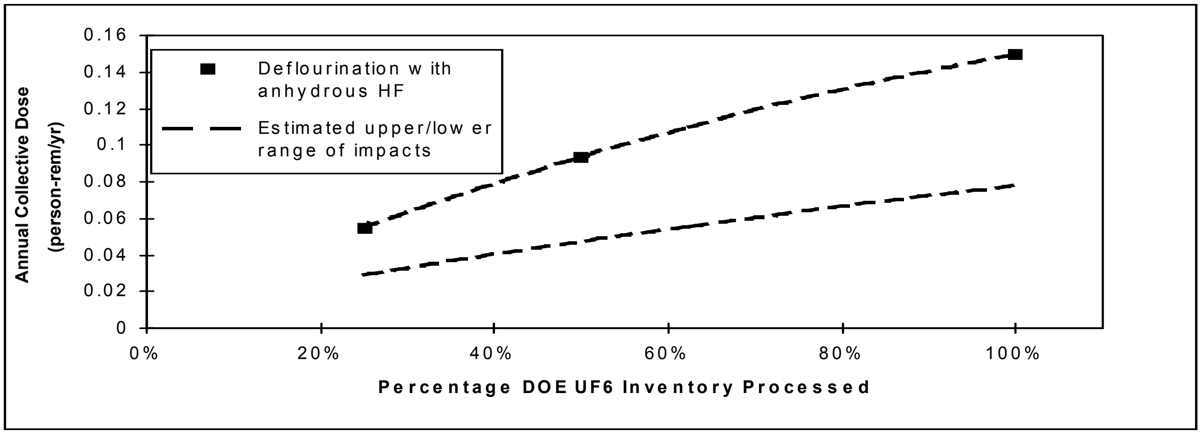

FIGURE 8.7 Estimated Annual Collective Dose to Members of the Public from the Conversion of UF_6 to UO_2 (The upper and lower ranges reflect differences in conversion technologies.)

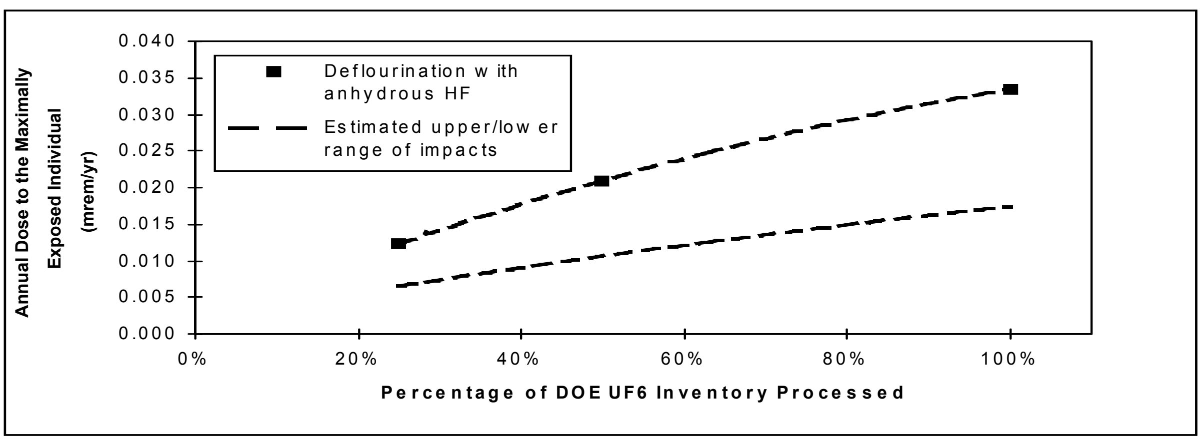

FIGURE 8.8 Estimated Annual Dose to the General Public MEI from the Conversion of UF_6 to UO_2 (The upper and lower ranges reflect differences in conversion technologies.)

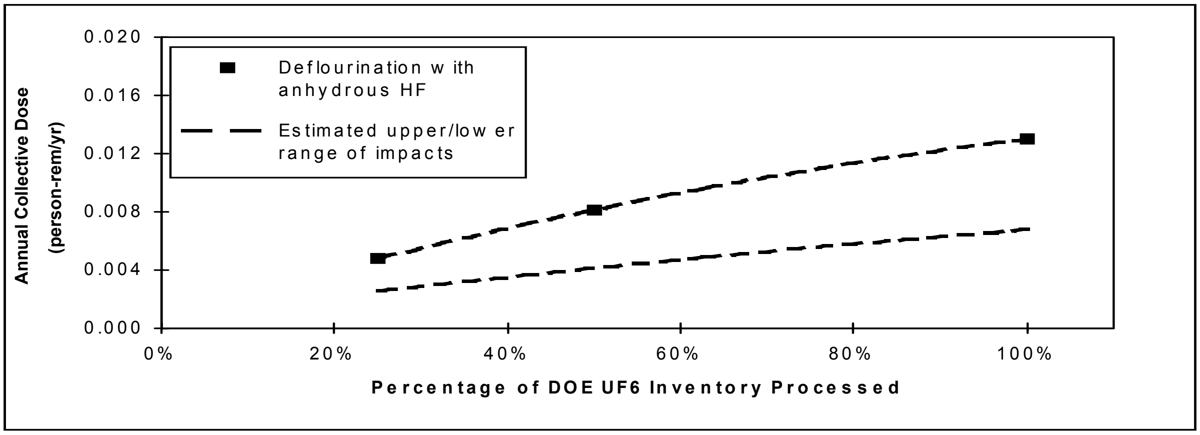

FIGURE 8.9 Estimated Annual Collective Dose to Noninvolved Workers from the Conversion of UF_6 to UO_2 (The upper and lower ranges reflect differences in conversion technologies.)

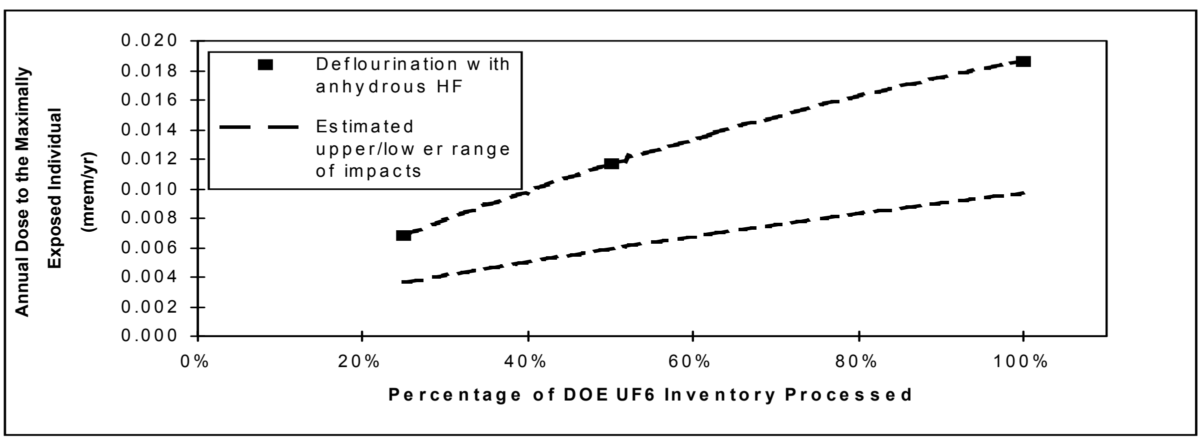

FIGURE 8.10 Estimated Annual Dose to the Noninvolved Worker MEI from the Conversion of UF_6 to UO_2 (The upper and lower ranges reflect differences in conversion technologies.)

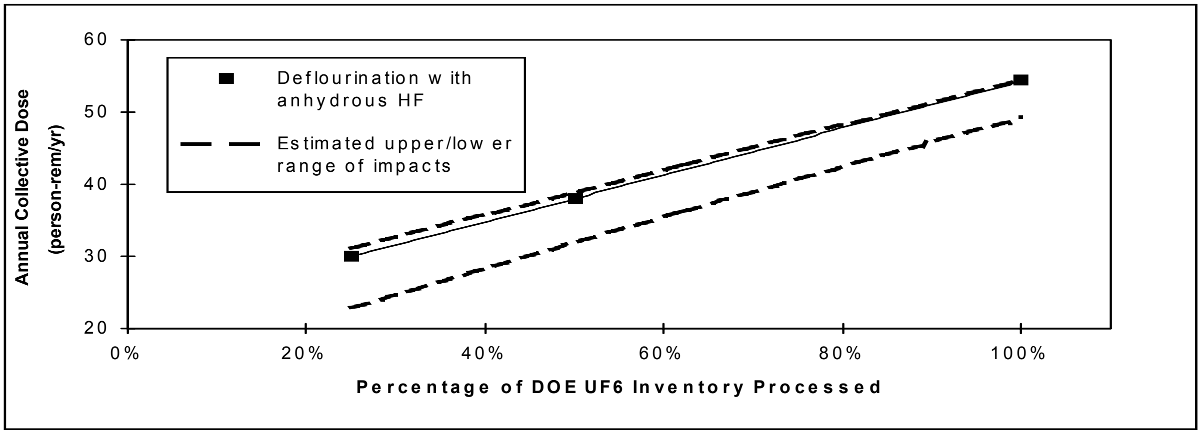

FIGURE 8.11 Estimated Annual Collective Dose to Involved Workers from the Conversion of UF_6 to UO_2 (The upper and lower ranges reflect differences in conversion technologies.)

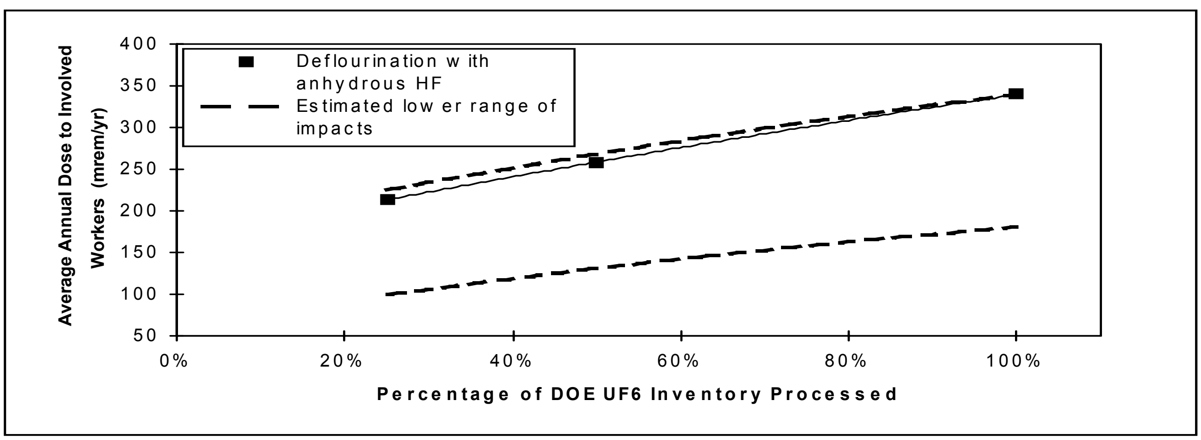

FIGURE 8.12 Estimated Annual Average Individual Dose to Involved Workers from the Conversion of UF_6 to UO_2 (The upper and lower ranges reflect differences in conversion technologies.)

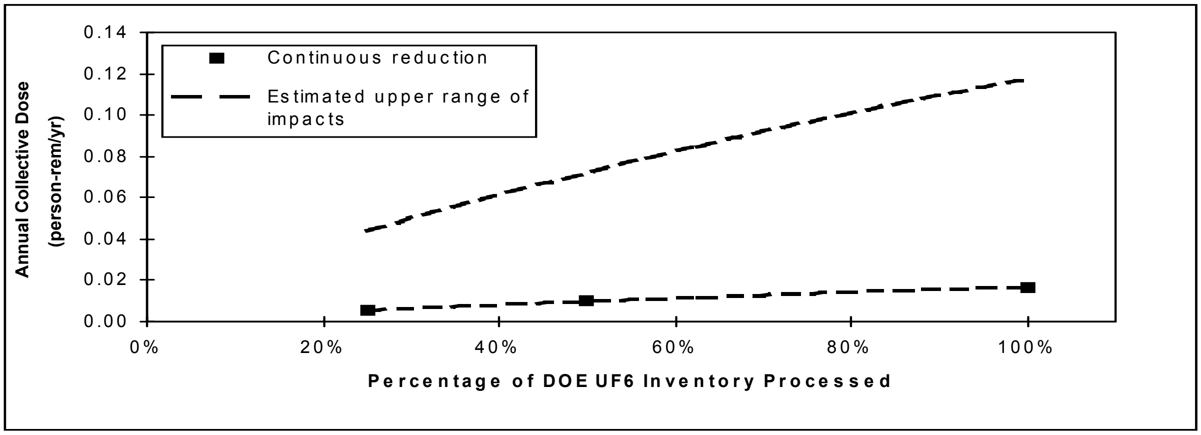

FIGURE 8.13 Estimated Annual Collective Dose to Members of the Public from the Conversion of UF_6 to Uranium Metal (The upper and lower ranges reflect differences in conversion technologies.)

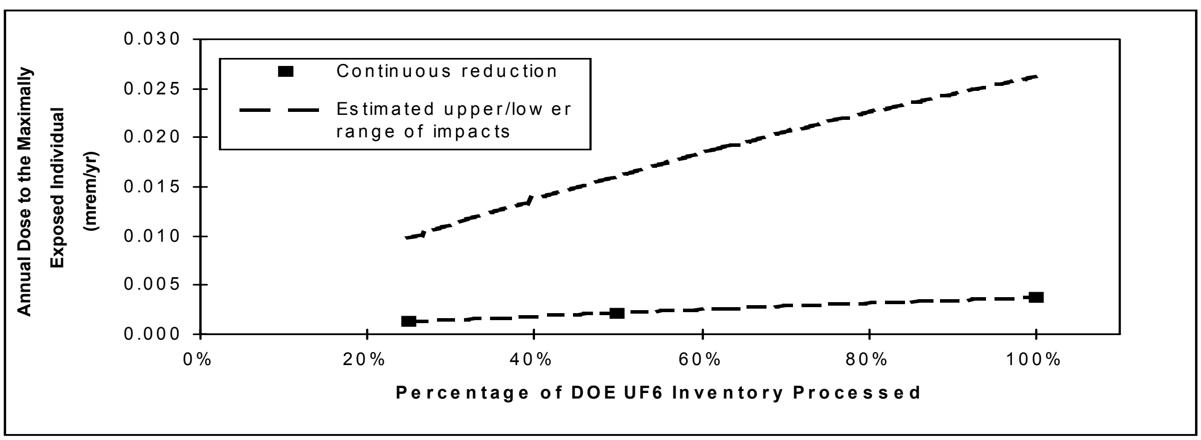

FIGURE 8.14 Estimated Annual Dose to the General Public MEI from the Conversion of UF_6 to Uranium Metal (The upper and lower ranges reflect differences in conversion technologies.)

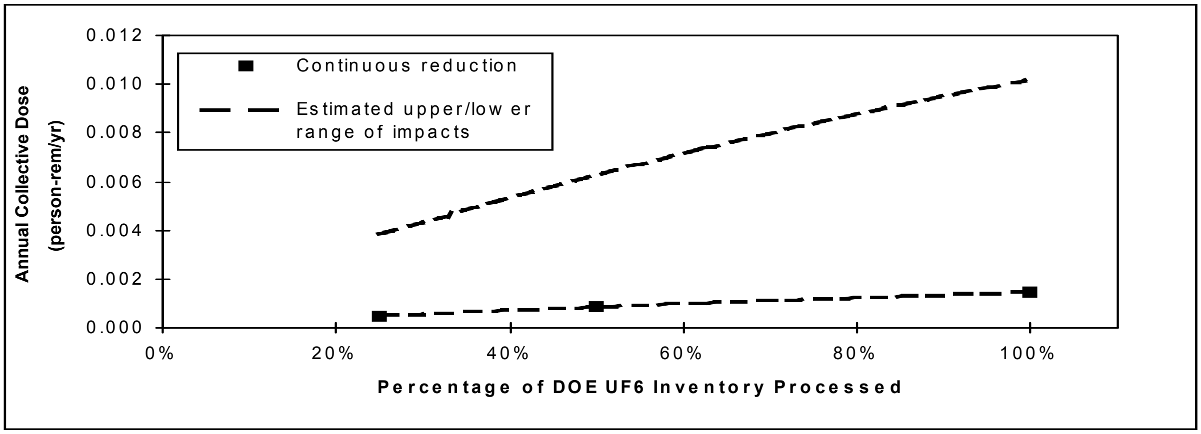

FIGURE 8.15 Estimated Annual Collective Dose to Noninvolved Workers from the Conversion of UF_6 to Uranium Metal (The upper and lower ranges reflect differences in conversion technologies.)

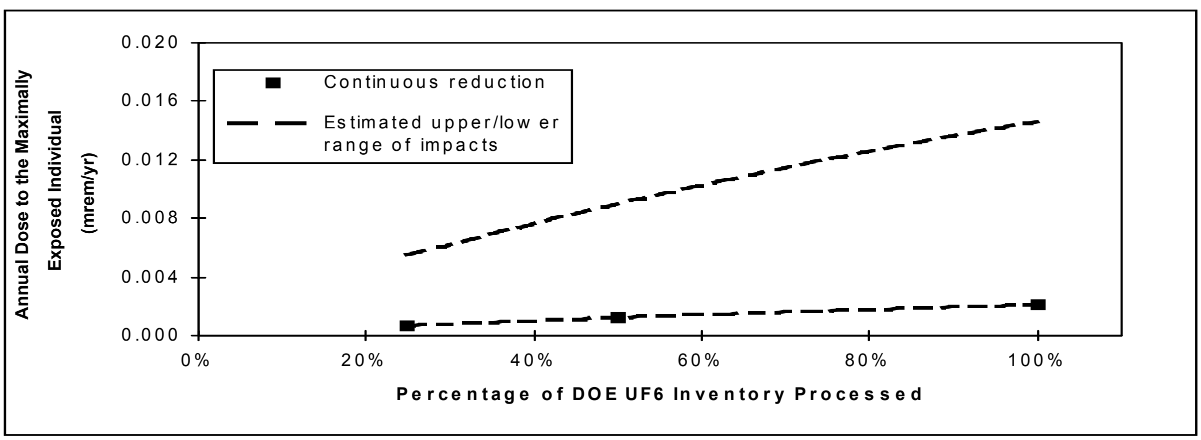

FIGURE 8.16 Estimated Annual Dose to the Noninvolved Worker MEI from the Conversion of UF_6 to Uranium Metal (The upper and lower ranges reflect differences in conversion technologies.)

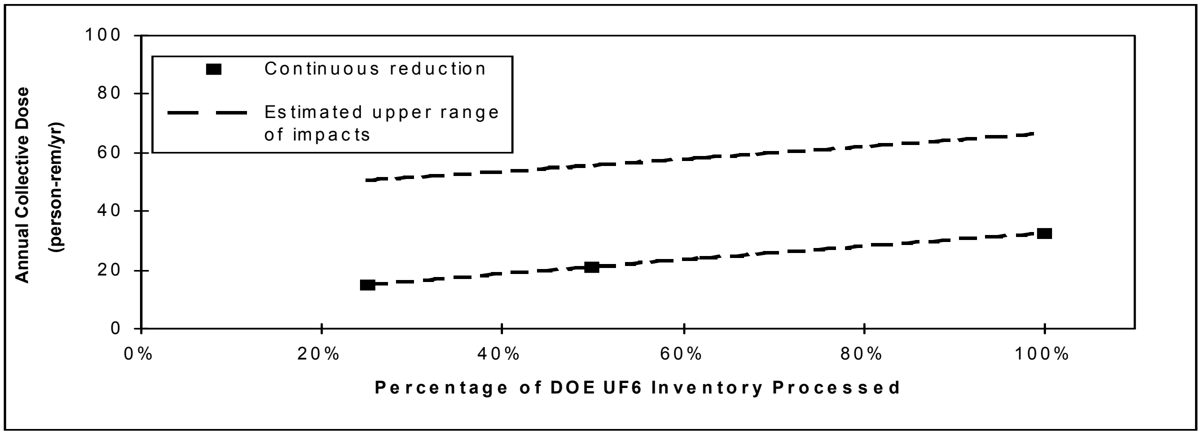

FIGURE 8.17 Estimated Annual Collective Dose to Involved Workers from the Conversion of UF_6 to Uranium Metal (The upper and lower ranges reflect differences in conversion technologies.)

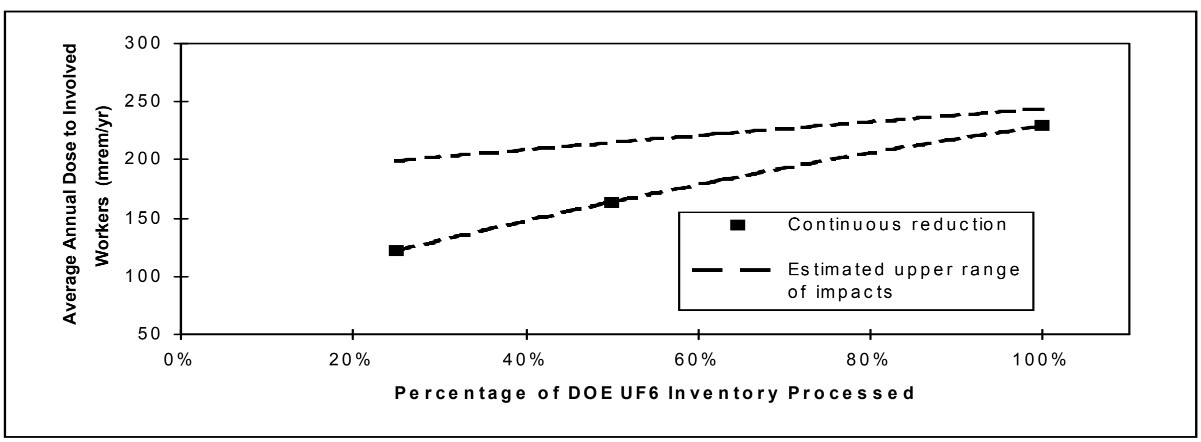

FIGURE 8.18 Estimated Annual Average Individual Dose to Involved Workers from the Conversion of UF_6 to Uranium Metal (The upper and lower ranges reflect differences in conversion technologies.)

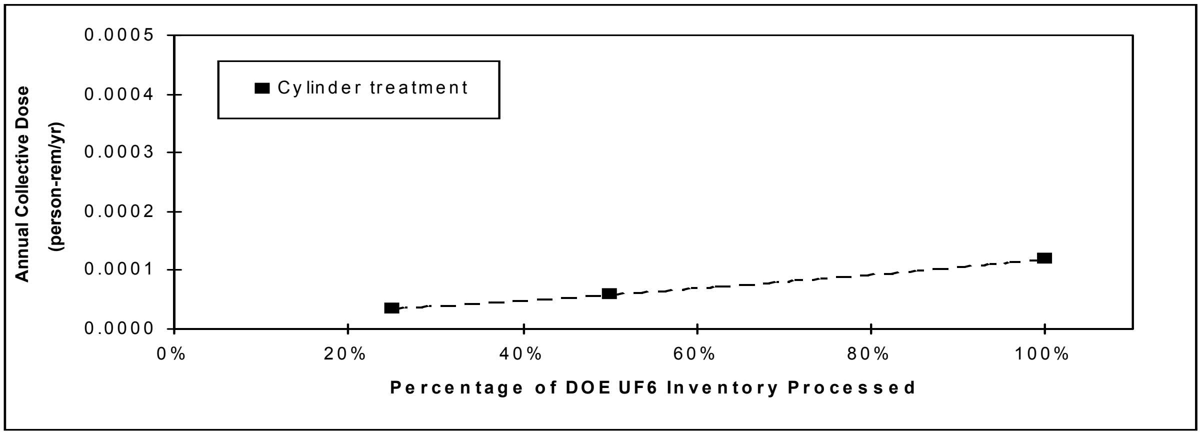

FIGURE 8.19 Estimated Annual Collective Dose to Members of the Public from the Cylinder Treatment Facility

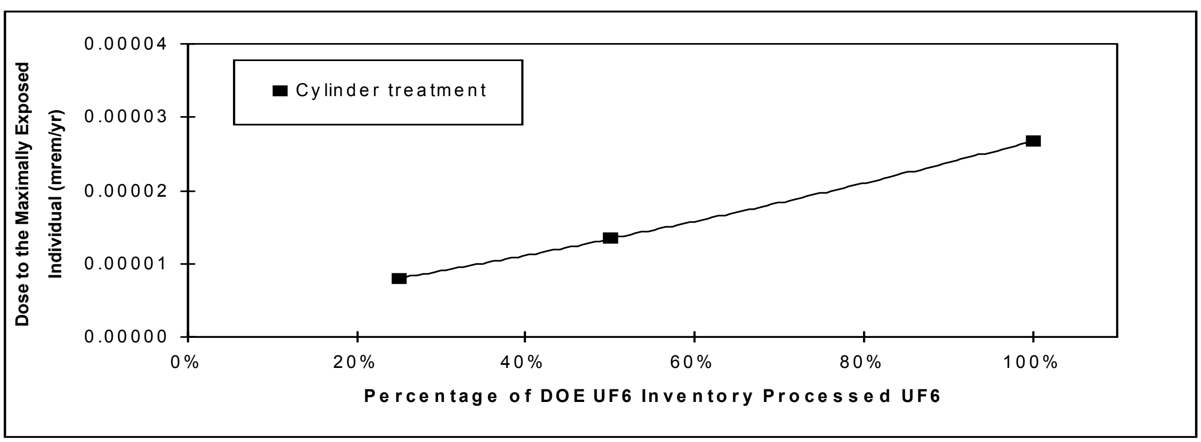

FIGURE 8.20 Estimated Annual Dose to the General Public MEI from the Cylinder Treatment Facility

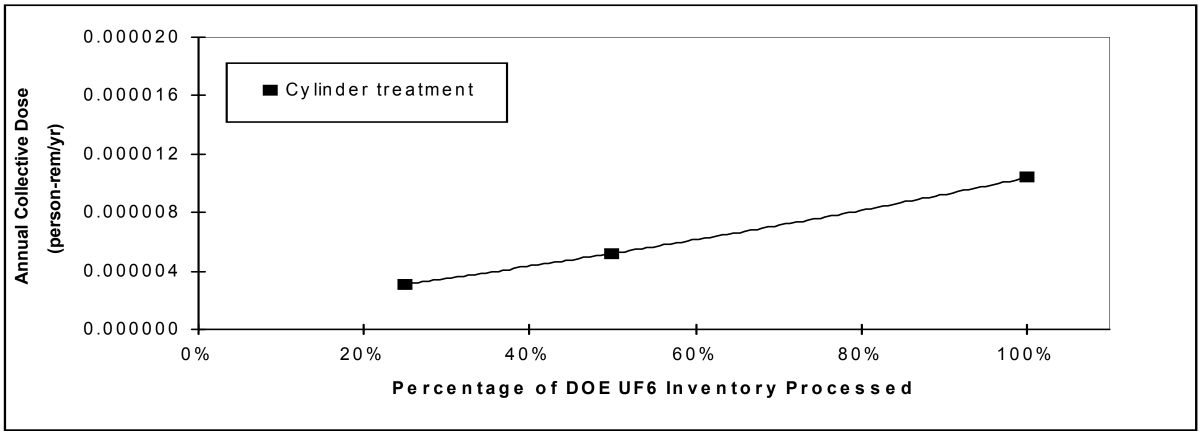

FIGURE 8.21 Estimated Annual Collective Dose to Noninvolved Workers from the Cylinder Treatment Facility

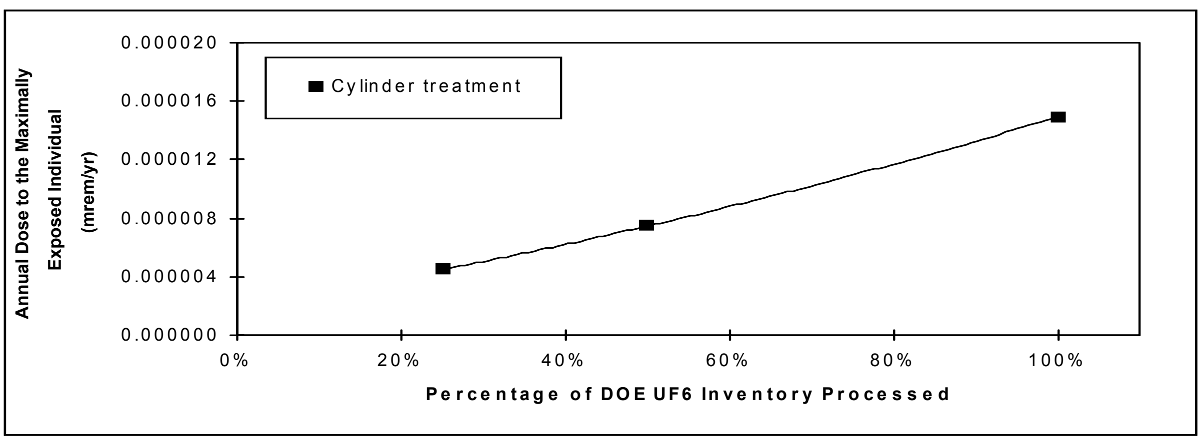

FIGURE 8.22 Estimated Annual Dose to the Noninvolved Worker MEI from the Cylinder Treatment Facility

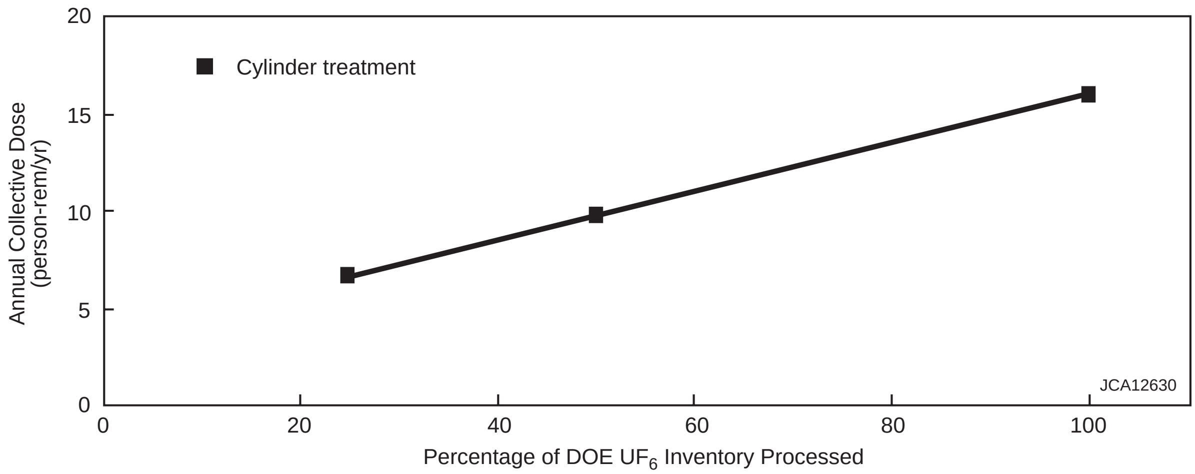

FIGURE 8.23 Estimated Annual Collective Dose to Involved Workers from the Cylinder Treatment Facility

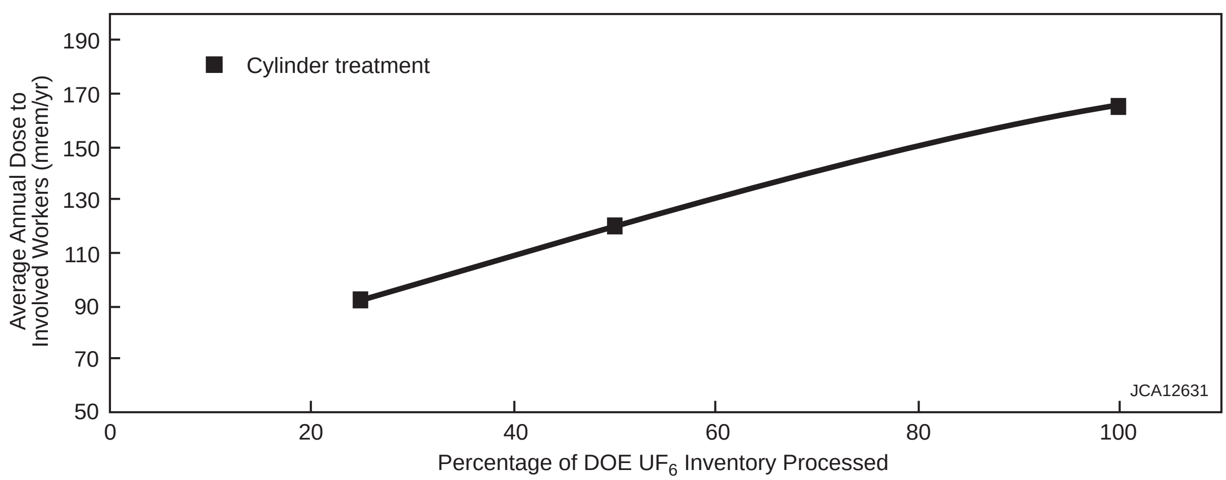

FIGURE 8.24 Estimated Annual Average Individual Dose to Involved Workers from the Cylinder Treatment Facility

8.2.1.2 Chemical Impacts

The estimated impacts from chemical exposures during the normal operation of full-scale (100%) facilities for converting depleted UF_6 to U_3O_8, UO_2, and uranium metal are described in Section 5.3.1.2. The results of the 100% case analyses indicated that noninvolved workers and members of the general public would receive very low exposures to chemicals from operation of the conversion facilities and that no adverse health impacts would be expected. For the 100% cases, the calculated hazard indices were much less than 1 for all three conversion options (a hazard index of greater than 1 indicates the potential for health impacts). For the parametric analysis of the 25% and 50% throughput cases, calculated hazard indices for noninvolved workers and members of the general public were proportionally smaller than those for the 100% cases. Therefore, because the hazard indices are much less than 1, no adverse health impacts from chemical exposures would be expected for throughput rates between 25% and 100%.

The chemical impacts from operations of the cylinder treatment facility were estimated to be less than the impacts from operations of the conversion facilities, therefore resulting in no adverse health impacts to noninvolved workers and the general public for the 25%, 50%, and 100% cases.

8.2.2 Human Health — Accident Conditions

8.2.2.1 Radiological Impacts

The estimated radiological impacts (radiation doses and LCFs) from potential accidents during operation of the full-scale (100%) conversion facilities are presented in Section 5.3.2.1. Analysis of the 100% cases considered a range of accidents in four frequency categories; results are presented only for those accidents in each category that would have the greatest consequences (bounding accidents). Similar sets of accidents covering the same four frequency categories are defined in the engineering analysis report (LLNL 1997) for the 25% and 50% throughput cases.

On the basis of the assessment of the 25% and 50% conversion cases, the radiological accident impacts associated with each of the parametric cases would be the same as those presented for the 100% cases in Section 5. The impacts would be the same because the bounding accidents within each frequency category (those producing the greatest consequences) would be the same for all cases (100%, 50%, and 25%). The bounding accidents would be the same because they would involve only a limited amount of material that would be at risk under accident conditions regardless of the facility size or throughput. Some of the impacts from other accidents considered for the 25% and 50% cases (nonbounding) would be different than those for the 100% cases. In general, the impacts of these nonbounding accidents for the 50% and 25% cases would be less than those for the 100% cases because of the reduced throughput.

All accidents associated with the cylinder treatment facilities discussed in Section 5 would be the same for the parametric analysis (LLNL 1997). The frequencies of some accidents, such as drum spills, might decrease as the number of drums handled decreased with facility throughput. However, it is not expected that the small changes in frequencies for specific accidents would change the overall frequency category for those accidents. As a result, the accident impacts associated with the cylinder treatment facility would be the same for all parametric cases.

8.2.2.2 Chemical Impacts

The estimated chemical impacts from potential accidents during the operation of full-scale (100%) conversion facilities are presented in Section 5.3.2.2. The analysis of the 100% cases considered a range of accidents in four frequency categories; results are presented only for those accidents in each category that would have the greatest consequences (bounding accidents). Similar sets of accidents covering the same four frequency categories are defined in the engineering analysis report (LLNL 1997) for the 25% and 50% throughput cases.

As for the radiological accident impacts, the chemical accidents producing the greatest consequences for the 25% and 50% parametric cases would be the same as those assessed for the 100% cases in Section 5. The impacts would be similar because the bounding accidents within most frequency categories would be the same for the 100%, 50%, and 25% cases, and in those cases where the accidents were different, no adverse chemical impacts were estimated. The bounding accidents would be the same because they would involve only a limited amount of material that would be at risk under accident conditions regardless of the facility size or throughput. Some of the impacts from other accidents considered for the 25% and 50% cases (nonbounding accidents) would be different than those for the 100% cases. In general, the impacts of these other accidents for the 50% and 25% cases would be less than those for the 100% cases because of the reduced throughput.

All accidents associated with the cylinder treatment facilities discussed in Section 5 would be the same for the parametric analysis (LLNL 1997). The frequencies of some accidents, such as drum spills, might decrease as the number of drums handled decreased with facility throughput. However, it is not expected that the small changes in frequencies for specific accidents would change the overall frequency category for those accidents. As a result, the overall chemical accident impacts associated with cylinder treatment would be the same for all parametric cases.

8.2.2.3 Physical Hazards

The estimated health impacts, such as on-the-job injuries and fatalities, from potential physical accidents during the construction and operation of full-scale (100%) conversion facilities are presented in Section 5.3.2.3. The impacts of the 25% and 50% cases would be smaller than those for the 100% cases, although the decrease would not be proportional to the reduction in throughput (i.e., the impacts for the 50% case would be greater than half of the impacts for the 100% case).

The estimated total fatalities over the entire period of construction and operations for the U_3O_8 conversion options for the 25%, 50%, and 100% cases would be 0.29, 0.32, and 0.35, respectively (both conversion options analyzed resulted in the same fatality estimates). For the UO_2 conversion options, the estimated total fatalities for the 25%, 50%, and 100% cases would range from 0.35 to 0.49, 0.38 to 0.54, and 0.40 to 0.59, respectively. For the metal conversion options, total fatalities for the 25%, 50%, and 100% cases would range from 0.33 to 0.49, 0.36 to 0.52, and 0.4 to 0.55, respectively.

The total numbers of injuries over the entire period of construction and operation of the specific U_3O_8, UO_2, and metal conversion options analyzed parametrically are illustrated by the solid black line in Figures 8.25 through 8.27. The estimated upper ranges of impacts for all options examined in the PEIS are illustrated by the dotted lines in the figures (because both U_3O_8 options analyzed resulted in the same number of estimated injuries, only one line is shown in Figure 8.25). The ranges of predicted injury incidence for the conversion options would be roughly comparable, reflecting the generally similar requirements for constructing and operating the three types of conversion facilities.

The estimated fatalities for the 25%, 50%, and 100% cases of construction and operation of a cylinder treatment facility would be 0.13, 0.16, and 0.19, respectively. The estimated number of injuries over the entire period of construction and operations would range from 122 to 170. The impacts are shown in Figure 8.28 for throughputs ranging from 25% to 100%.

8.2.3 Air Quality

The estimated impacts on air quality during construction and operation of full-scale (100%) conversion facilities are presented in detail in Section 5.3.3. All of the pollutant concentrations produced by the 100% capacity version of the conversion facilities would be well below their respective air quality standards, with the possible exception of dust emissions during construction. During construction, short-term particulate concentrations were estimated to potentially approach the applicable air quality standards for all options, although the condition would be temporary and minimized by good construction practices. The air quality impacts calculated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases. During construction, short-term impacts for the parametric cases would be less than those for the 100% cases, and impacts during operations would also be negligible. However, the air quality impacts from operations would not scale proportionally with facility capacities. The impacts from a 25% capacity plant would be from about 45% to 100% of those from the full-capacity plant, depending on the specific source of the emissions.

All of the pollutant concentrations produced by the 100% capacity version of the cylinder treatment facility would be well below the respective air quality standards (see Appendix F, Section F.3.3). The air quality impacts calculated for the 25% and 50% parametric cases, based on

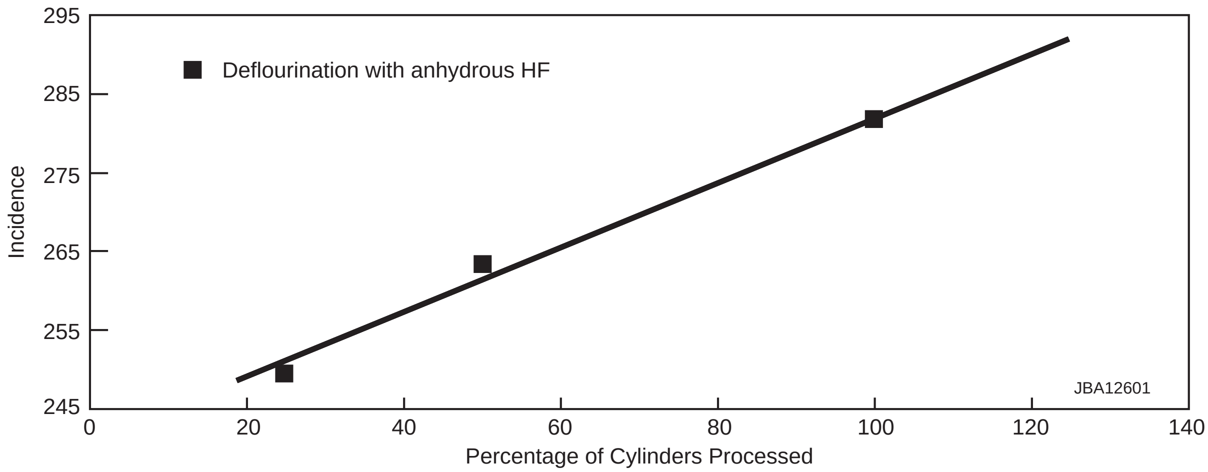

FIGURE 8.25 Estimated Number of On-the-Job Injuries (for entire construction and operational periods) for the Conversion of UF_6 to U_3O_8 (No range is presented because the number of injuries would be almost identical for the different U_3O_8 conversion technologies.)

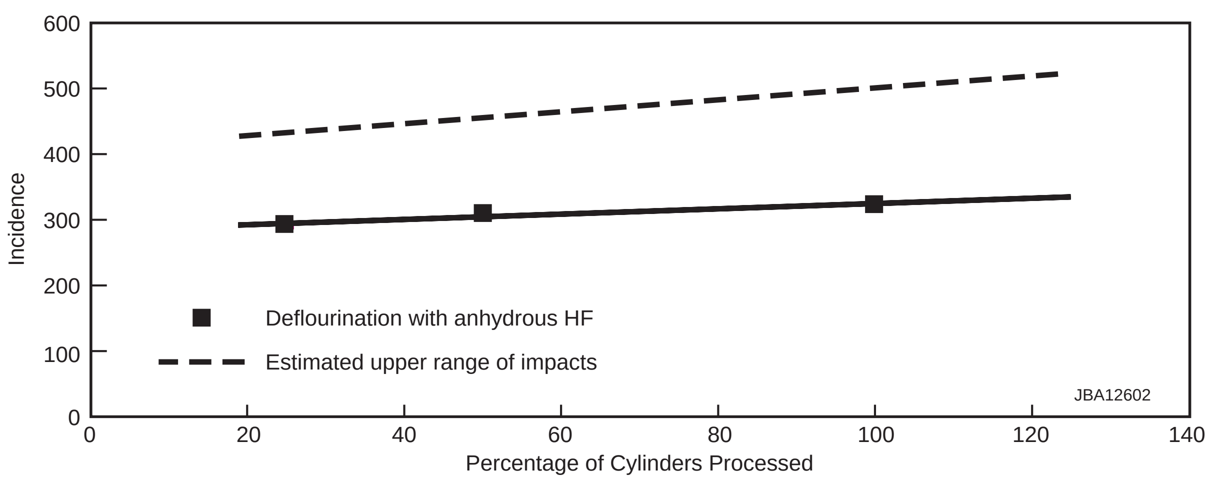

FIGURE 8.26 Estimated Number of On-the-Job Injuries (for entire construction and operational periods) for the Conversion of UF_6 to UO_2 (The ranges reflect differences in UO_2 conversion technologies.)

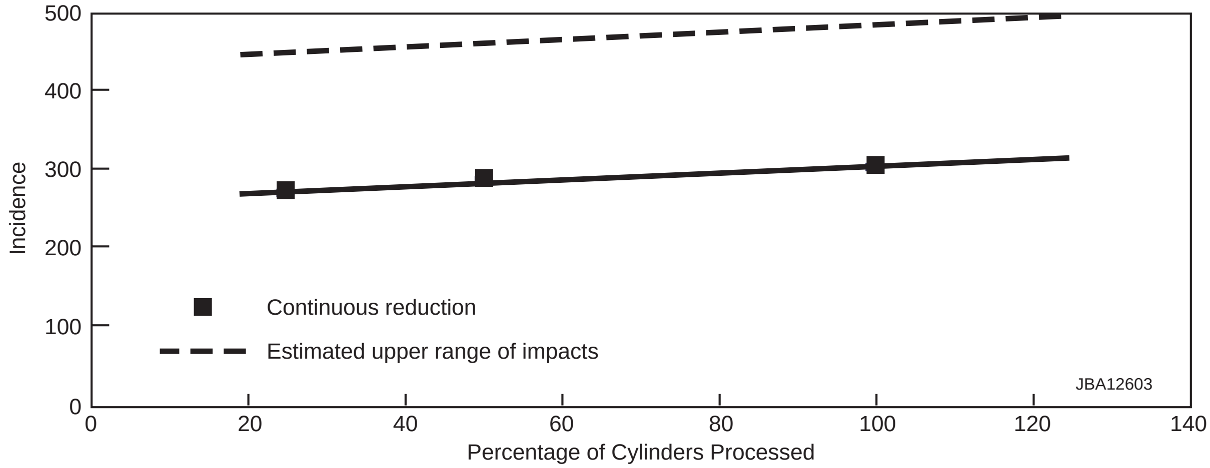

FIGURE 8.27 Estimated Number of On-the-Job Injuries (for entire construction and operational periods) for the Conversion of UF_6 to Uranium Metal (The ranges reflect differences in uranium metal conversion technologies.)

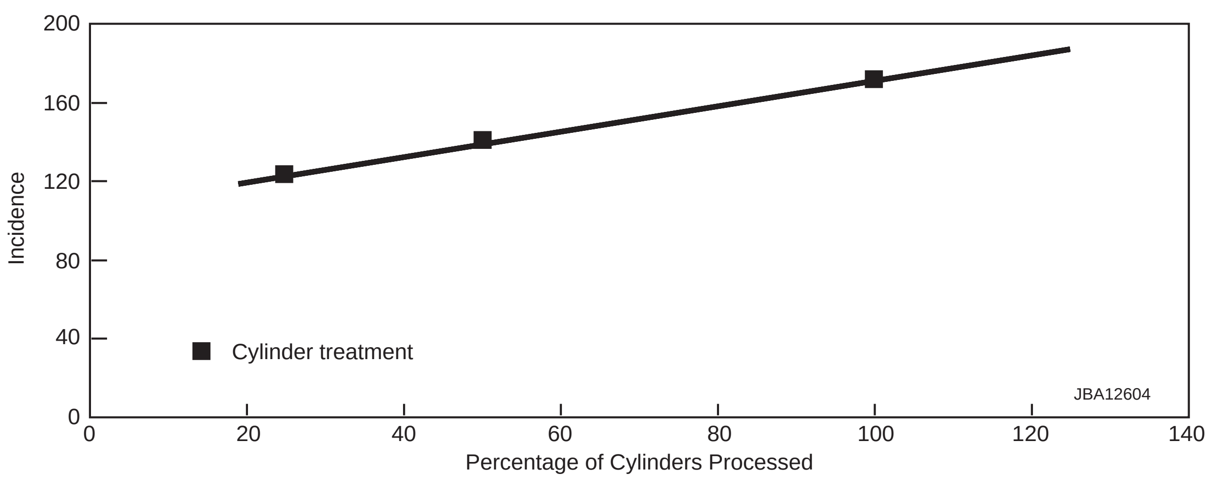

FIGURE 8.28 Estimated Number of On-the-Job Injuries (for entire construction and operational periods) for the Cylinder Treatment Facility

information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases, and thus would also be negligible.

8.2.4 Water and Soil

8.2.4.1 Surface Water

The estimated impacts on surface water during construction, operation, and potential accidents for full-scale (100%) conversion facilities and the cylinder treatment facility are presented in detail in Section 5.3.4.1. The potential impacts evaluated included changes in runoff, changes in quality, and floodplain encroachment. The impacts to surface water from the 100% cases were found to be negligible for all three conversion options. The impacts to surface water estimated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases, and thus would also be negligible.

8.2.4.2 Groundwater

The estimated impacts on groundwater during construction, operation, and potential accidents for full-scale (100%) conversion facilities and the cylinder treatment facility are presented in detail in Section 5.3.4.2. The potential impacts evaluated included changes in the depth to groundwater, the direction of groundwater flow, recharge, and quality. The impacts to groundwater from the 100% cases were found to be negligible for all three conversion options. The impacts calculated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases, and thus would also be negligible.

8.2.4.3 Soil

The estimated impacts to soil during construction, operation, and potential accidents for full-scale (100%) conversion facilities and the cylinder treatment facility are presented in detail in Section 5.3.4.3. The potential impacts evaluated included changes in topography, permeability, quality, and erosion potential. The impacts to soil from the 100% cases were found to be negligible for all three conversion options. The impacts calculated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases, and thus would also be negligible.

8.2.5 Socioeconomics

The socioeconomic impacts of U_3O_8, UO_2, and metal conversion and cylinder treatment facilities for the 50% and 25% parametric cases would be less than the impacts of the base-case facility sizes. Cost information was not available in sufficient detail to allow an analysis of impacts using the same methodology that was used for the base cases. The impacts of parametric cases were therefore assessed qualitatively, based on the assumption that changes in the cost of equipment, materials, and labor between cases would be proportional to changes in total life-cycle cost. Compared with base-case facility sizes, smaller conversion and cylinder treatment facilities would result in the following: less direct and indirect employment and income would be created in the ROI; fewer people would migrate into the ROI with fewer total jobs created, meaning fewer rental and owner-occupied houses would be needed; and the impact on local jurisdictional revenues and expenditures would be smaller.

8.2.6 Ecology

Site preparation for the construction of conversion and cylinder treatment facilities would result in the disturbance of biotic communities, including the permanent replacement of habitat with structures, paved areas, and landscaping (see Section 8.2.9). Existing vegetation would be destroyed during land-clearing activities. Wildlife would be disturbed by land clearing, noise, and human presence.

Normal operations of the conversion facility would generate minor atmospheric emissions of criteria pollutants, HF, and uranium compounds. However, resulting air concentrations would be expected to be negligible under all conversion options analyzed, resulting in negligible impacts to ecological resources.

Effluent discharges to surface water would contain low levels of contaminants, including uranium. However, under all three conversion cases, contaminant concentrations in the undiluted effluent would be below levels that adversely affect aquatic biota.

Depending on the exact location of the conversion facility, the loss of approximately 10 to 30 acres (4 to 12 ha) of undeveloped land and habitat, representing the rounded 25-100% capacity range for oxide and metal conversion facilities, might constitute a minor to moderate adverse impact to vegetation and wildlife. For the cylinder treatment facility, the loss of 6.8 to 8.7 acres (2.8 to 3.5 ha) of undeveloped land and the permanent loss of 3.2 to 4.5 acres (1.3 to 1.8 ha) of habitat would constitute a negligible to low adverse impact. (See Section 8.2.9 for details on land use assumptions.) When these facilities would be sited, all appropriate measures would be taken to preclude or minimize such impacts.

Impacts to wetlands and state and federally protected species due to facility construction would depend on location of the facility within the site. Avoidance of wetland areas would be included during facility planning. Impacts to air quality, surface water, groundwater, and soil during construction and operations would be expected to be negligible, as would the resulting derived impacts to ecological resources.

8.2.7 Waste Management

The estimated impacts from waste management operations for construction and operation of full-scale (100%) conversion facilities are presented in detail in Section 5.3.7. Potential moderate impacts to site, regional, and national waste management operations were found for all 100% throughput conversion option cases. On the basis of information provided in the engineering analysis report (LLNL 1997), the impacts resulting from construction and operation of the conversion facility for the 25% and 50% parametric cases would be roughly linear for throughput ranges of between 25% and 100%. Minimal waste management impacts would result from construction-generated wastes. The annual amounts of waste generated during facility operations are shown in Table 8.2. Overall, the waste input resulting from normal operations at the conversion facilities would have a low to moderate impact on waste management capacities locally or across the DOE complex.

There is a significant possibility that the MgF_2 waste generated in the conversion to metal option would be sufficiently contaminated with uranium to require disposal as LLW rather than as solid nonhazardous waste. Such disposal might require the MgF_2 waste to be grouted, generating up to 12,300 m^3/yr of grouted waste for LLW disposal. This volume represents a low (5.8%) impact to the DOE complexwide LLW disposal capacity for the 100% throughput case (scales linearly for the three throughput cases).

8.2.8 Resource Requirements

The estimated impacts from resource requirements during construction and operation of full-scale (100%) conversion facilities are presented in detail in Section 5.3.8. The impacts on resources would be expected to be small for the 100% capacity conversion case. Although the resource requirements for the two conversion parametric analyses would be less than the 100% case, the reduction in requirements would not be linearly proportional to the decrease in throughput. For example, the amount of material required to construct a conversion facility for the 25% throughput case would be only about 10 to 20% less than the amount required for the 100% throughput facility due to economies of scale.

Construction and operation of the proposed conversion options would consume irretrievable amounts of electricity, fuel, concrete, steel and other metals, water, and miscellaneous chemicals. The total quantities of commonly used materials would not be expected to be significant. No strategic and critical materials (e.g., Monel or Inconel) in significant quantities are projected to be consumed during construction or operation. The conversion options are not considered resource-intensive, and the resources required are generally not considered rare or unique. Furthermore,

TABLE 8.2 Waste Generation from Conversion Facilities for 100%, 50%, and 25% Throughput Cases

	Waste Generated (m^3/yr) by Conversion to U_3O_8, UO_2, or Uranium Metal for Three Throughput Cases								
	U_3O_8			UO_2			Uranium Metal		
Waste Category	100%	50%	25%	100%	50%	25%	100%	50%	25%
Low-level radioactive waste									
Combustible	77	73	70	88	84	82	77	71	69
Noncombustible	62	45	33	82	63	45	112	88	69
Grouted	466	233	116	466	233	116	37	26	18
Low-level mixed waste	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Hazardous waste	7.3	6.7	6.1	7.3	6.7	6.1	7.3	6.7	6.1
Nonhazardous waste									
Solids	535	512	490	612	585	566	6,680[a]	3,590[a]	2,040[a]
Wastewater	58,000	36,300	24,600	74,900	47,300	31,000	96,500	57,500	37,500
Sanitary waste	4,920	4,730	4,540	5,680	5,380	5,220	5,300	4,950	4,800

[a] Includes the following volumes of MgF_2 waste: 6,120 m^3/yr for the 100% case; 3,060 m^3/yr for the 50% case, and 1,530 m^3/yr for the 25% case.

committing any of these resources would not be expected to cause a negative impact on the availability of these resources within local areas or nationally for the 100%, 50%, and 25% cases.

Construction and operation of a cylinder treatment facility would also consume irretrievable amounts of electricity, fuel, concrete, steel, water, and miscellaneous gases and chemicals. Similar to the conversion facilities, the cylinder treatment facility option would not be expected to result in negative impacts relative to its resource requirements.

8.2.9 Land Use

8.2.9.1 Conversion to U_3O_8

Potential impacts to land use from the construction and operation of a U_3O_8 conversion facility would include the acquisition and clearing of required land, minor and temporary disruptions to contiguous land parcels, and increases in vehicular traffic. Site preparation for the construction of a facility to convert 25%, 50%, and 100% of the depleted UF_6 inventory to U_3O_8 by defluorination with anhydrous HF would require the disturbance of approximately 14, 16, and 20 acres (5.5, 6.4, and 8.1 ha), respectively. Within this disturbed area, the facility would require the permanent replacement of approximately 9, 11, and 13 acres (3.6, 4.2, and 5.3 ha) with structures, paved areas, and landscaping. The amount of land required for the other U_3O_8 conversion technologies would be roughly similar. Even the highest areal requirement would not be great enough to generate other than negligible, temporary disturbance impacts, particularly if the facility was sited in a location already dedicated to similar use with immediate access to infrastructure and utility support.

Impacts to land use outside the boundaries of a U_3O_8 conversion facility at 25%, 50%, or 100% of throughput would be limited to negligible, temporary traffic impacts associated with project construction.

8.2.9.2 Conversion to UO_2

Impacts to land use from the construction and operation of a UO_2 conversion facility, regardless of throughput capacity case, would be negligible and limited to minor and temporary disruptions to contiguous land parcels and increases in vehicular traffic associated with construction activities. Site preparation for the construction of a facility to convert 25%, 50%, and 100% of the depleted UF_6 inventory to UO_2 by the dry process with anhydrous HF would require the disturbance of approximately 16, 19, and 24 acres (6.4, 7.9, and 9.7 ha), respectively. Within this disturbed area, the facility would require the permanent replacement of approximately 10, 13, and 15 acres (4.0, 5.2, and 5.9 ha) with structures, paved areas, and landscaping. The amount of land required for the other UO_2 conversion technologies would be roughly similar, except for gelation, which would require a slightly greater amount of land. Even the highest areal requirement would not be great enough to generate other than negligible, temporary disturbance impacts associated with construction.

Impacts to land use outside the boundaries of a UO_2 conversion facility at 25%, 50%, or 100% of throughput would be limited to minor, temporary traffic impacts associated with project construction.

8.2.9.3 Conversion to Uranium Metal

Impacts to land use from the construction and operation of a facility for uranium metal conversion, regardless of throughput capacity case, would be negligible and limited to minor and temporary disruptions to contiguous land parcels and increases in vehicular traffic associated with construction activities. Site preparation for the construction of a facility to convert 25%, 50%, and 100% of the depleted UF_6 inventory to uranium metal by the continuous metallothermic production technology would require the disturbance of approximately 17, 21, and 26 acres (6.8, 8.6, and 10.6 ha), respectively. Within this disturbed area, the facility would require the permanent replacement of approximately 12, 14, and 15 acres (4.8, 5.5, and 6.2 ha) with structures, paved areas, and landscaping. The amount of land required for the other uranium metal conversion technology would be roughly similar. Even the highest areal requirement would not be great enough to generate other than negligible, temporary disturbance impacts associated with construction.

Impacts to land use outside the boundaries of a conversion-to-metal facility at 25%, 50%, or 100% of throughput would be limited to minor, temporary traffic impacts associated with project construction.

8.2.9.4 Cylinder Treatment Facility

Other than negligible and temporary disruptions to contiguous land parcels, and slight increases in vehicular traffic, virtually no impacts would be expected from a cylinder treatment facility at 25%, 50%, or 100% of throughput capacity. Site preparation for construction of a stand-alone cylinder treatment facility for 25%, 50%, and 100% of the depleted UF_6 inventory would require the disturbance of approximately 6.8, 7.5, and 8.7 acres (2.8, 3.0, and 3.5 ha), respectively. Within this disturbed area, the facility would require the permanent replacement of approximately 3.2, 3.7, and 4.5 acres (1.3, 1.5, and 1.8 ha) with structures and paved areas.

Potential impacts to land use outside the boundaries of a site containing a cylinder treatment facility at 25%, 50%, or 100% of throughput capacity would be limited to negligible, temporary traffic impacts associated with project construction.

8.2.10 Other Impacts Considered But Not Analyzed in Detail

Other impacts could potentially occur if the conversion options considered in the PEIS were implemented — including impacts to cultural resources and environmental justice, as well as to aesthetics (e.g., visual environment), recreational resources, and noise levels, and impacts associated with decontamination and decommissioning of conversion facilities. These impacts, although considered, were not analyzed in detail for one or both of the following reasons:

- The impacts could not be determined at the programmatic level without consideration of specific locations for construction at the Portsmouth site, which are not currently known. These impacts would be more appropriately addressed in the second-tier NEPA documentation when specific locations are considered.

- Consideration of the impacts would not contribute to differentiation among the alternatives; therefore, it would not affect the decisions to be made in the ROD for the PEIS.

8.3 LONG-TERM STORAGE OPTIONS

The parametric analysis of the long-term storage options considered the environmental impacts of storing 25% and 50% of the depleted UF_6 inventory as UF_6 or as an oxide form. In both cases, it was assumed that the uranium material would be actively placed into storage over a 20-year period (from 2009 through 2028), and then stored for an additional 11-year period (from 2029 through 2039) with only routine monitoring and maintenance. The assessment considered the environmental impacts that would occur during (1) construction of a storage facility, (2) routine operations, and (3) potential storage facility accidents. The areas of impact and the methodologies used to evaluate the parametric cases were the same as those used to evaluate the 100% cases discussed in detail in Section 6. The supporting engineering data for the 25% and 50% parametric storage cases are provided in the engineering analysis report (LLNL 1997).

The environmental impacts for the 100% case are presented in Section 6 for (1) storage as UF_6 in yards and buildings, (2) storage as U_3O_8 in buildings and vaults, and (3) storage as UO_2 in buildings and vaults. For the purposes of the parametric analysis, storage as UF_6 in buildings and storage as UO_2 in buildings were considered in detail. These options were chosen to simplify the parametric analysis because all options were evaluated in detail for the 100% base case. The relationships between the options that were identified for the 100% case were used to infer the impacts for all of the long-term storage options for the parametric analysis.

8.3.1 Human Health — Normal Operations

8.3.1.1 Radiological Impacts

The estimated radiological impacts (radiation doses and LCFs) from the normal operation of full-scale (100%) storage facilities for depleted UF_6 cylinders, UO_2 drums, and U_3O_8 drums are described in Section 6.3.1.1. Similar impacts were calculated for the 50% and 25% storage facilities for the parametric analysis. Radiological impacts from the storage as UF_6, UO_2, and U_3O_8 would be limited to involved workers because emissions of uranium to the air and water would be expected to be negligible during normal operations. The radiological impacts for involved workers for the 100%, 50%, and 25% cases are shown in Figures 8.29 through 8.34. The range of impacts resulting from technology differences (i.e., differences between yard, building, and vault storage facilities) are represented by dashed lines in the figures. The results for the two parametric cases for storage in buildings are shown in the figures as solid points, with a curve drawn between the points to indicate how the impacts would vary as a function of the percent of depleted UF_6 processed. The upper and lower bounds of impacts for the 25% and 50% cases were estimated on the basis of the range determined for the different technologies for the 100% case. The area enclosed by the lines in the figures indicates the range of impacts expected for throughputs between 25% and 100%.

The results of the parametric analysis (as shown in Figures 8.29 and 8.34) indicate that the collective radiological impacts would scale relatively linearly with the total quantity of depleted UF_6 processed. The impacts of the 25% and 50% cases would be smaller than those for the 100% case, although the decrease would not be proportional to the reduction in throughput (i.e., the impacts for the 50% case would be greater than half of the impacts for the 100% case). The doses shown in the figures can be converted to the number (or risk) of LCFs by multiplying the doses (in rem or person-rem) by 0.0004 LCF/person-rem for workers. Additional discussion of the significance of the estimated doses is provided in Section 6.3.1.1.

Detailed numerical results for each of the parametric analyses can be found in Table 6.1 and the spreadsheet included on disk 4 under the file name store-tm.xls in Cheng et al. (1997).

8.3.1.2 Chemical Impacts

The estimated impacts from chemical exposures during the normal operation of full-scale (100%) storage facilities are described in Section 6.3.1.2. The results of the 100% case analyses indicated that noninvolved workers and members of the general public would receive very low exposures to chemicals from operation of all storage facilities and that no adverse health impacts would be expected. For the 100% cases, the calculated hazard indices were much less than 1 for all long-term storage options (a hazard index of greater than 1 indicates the potential for health impacts). For the parametric analysis of the 25% and 50% throughput cases, airborne emissions of

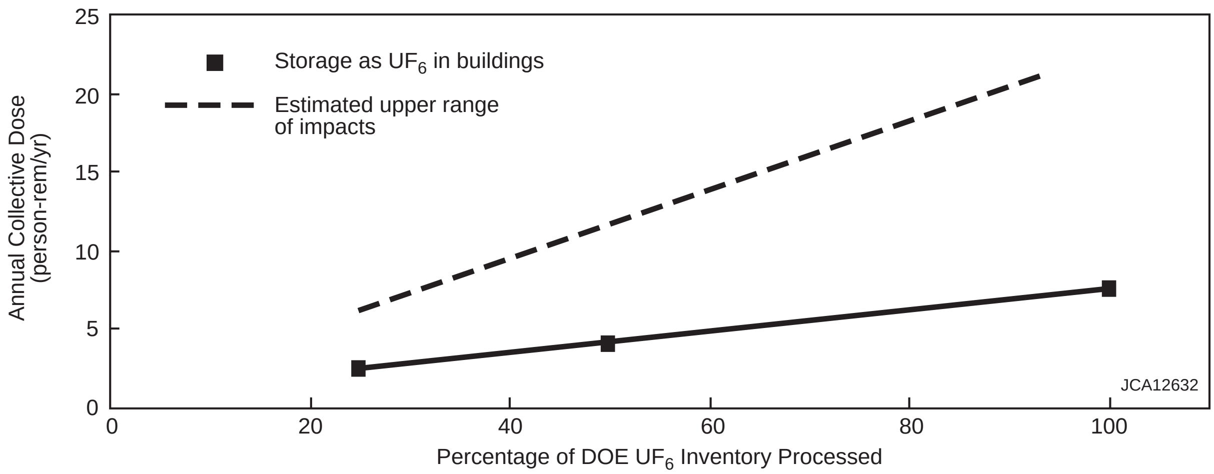

FIGURE 8.29 Estimated Annual Collective Dose to Involved Workers from Storage as UF_6 (The upper and lower ranges reflect differences in storage technologies.)

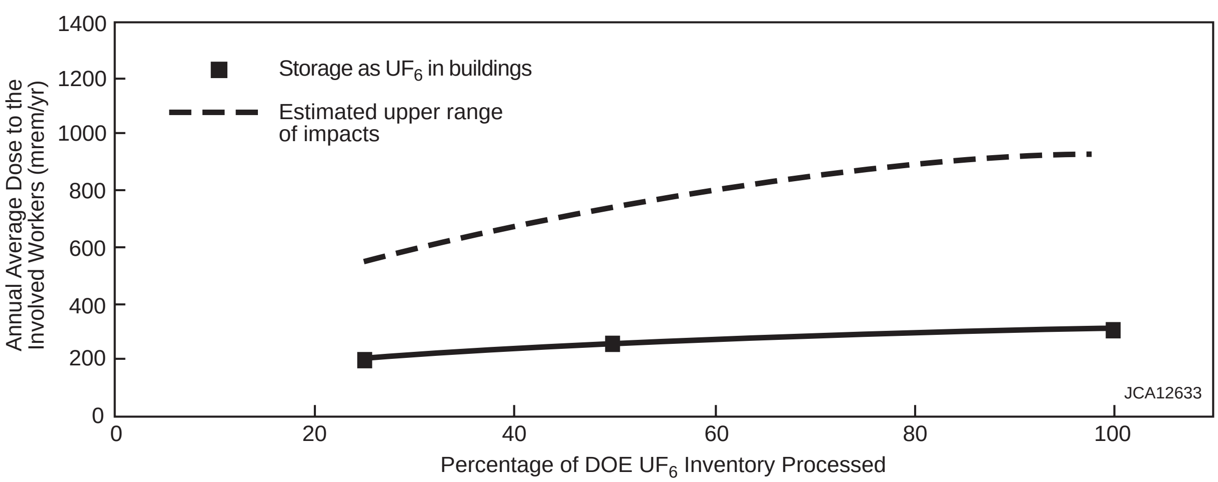

FIGURE 8.30 Estimated Annual Average Individual Dose to Involved Workers from Storage as UF_6 (The upper and lower ranges reflect differences in storage technologies.)

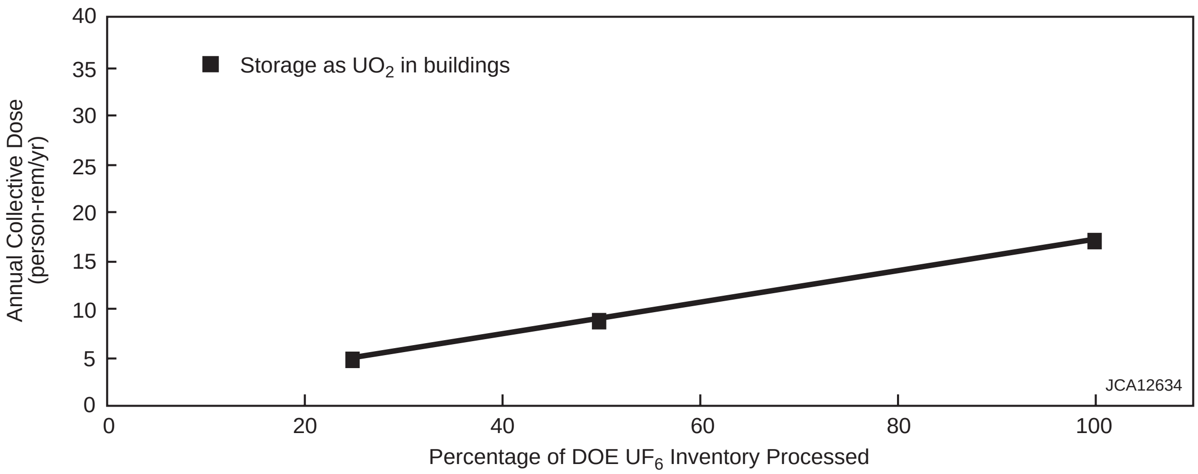

FIGURE 8.31 Estimated Annual Collective Dose to Involved Workers from Storage of UO_2 (The collective doses for the different technologies are about the same.)

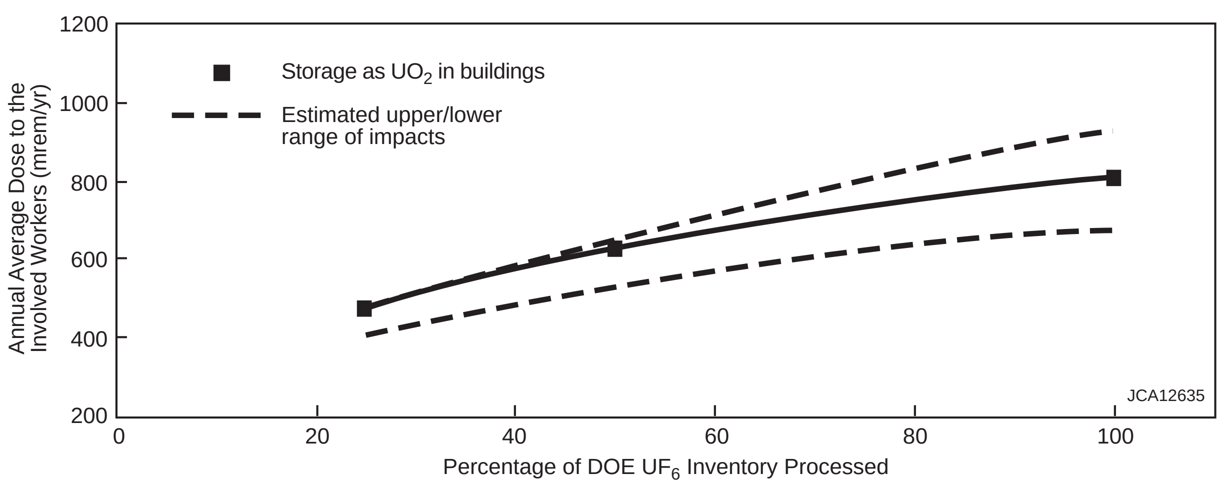

FIGURE 8.32 Estimated Annual Average Individual Dose to Involved Workers from Storage of UO_2 (The upper and lower ranges reflect differences in storage technologies.)

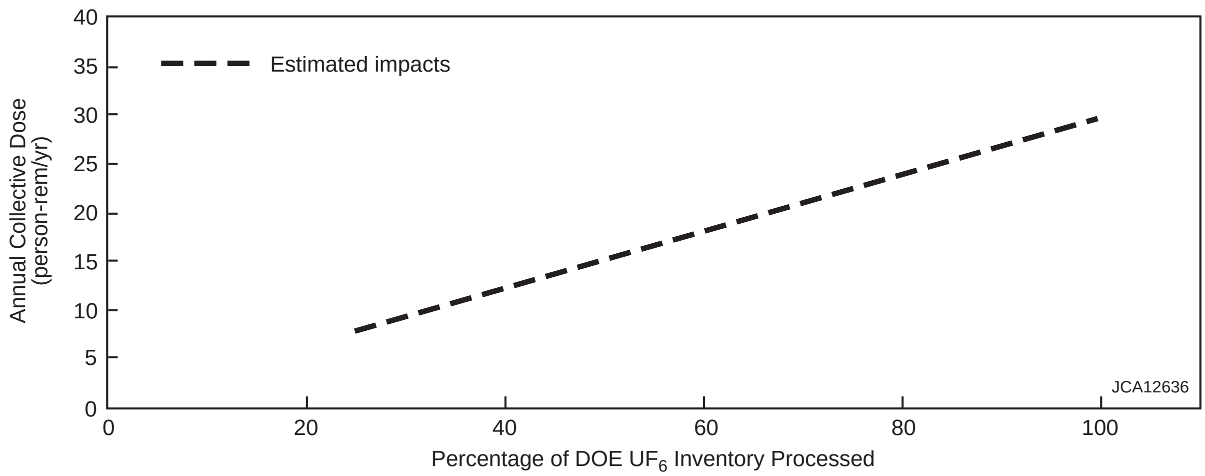

FIGURE 8.33 Estimated Annual Collective Dose to Involved Workers from Storage of U_3O_8 (The collective doses for different technologies are about the same.)

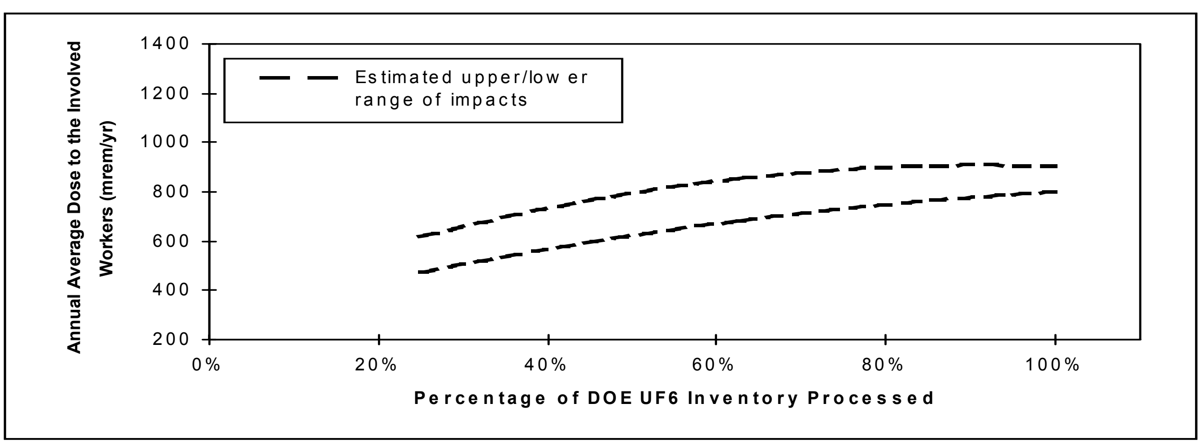

FIGURE 8.34 Estimated Annual Average Individual Dose to Involved Workers from Storage of U_3O_8 (The upper and lower ranges reflect differences in storage technologies.)

depleted uranium and HF during normal operations would be less than the 100% cases and extremely small (LLNL 1997). Therefore, by comparison with the 100% case results, no adverse health impacts from chemical exposures would be expected for throughput rates between 25% and 100% for all long-term storage options.

8.3.2 Human Health — Accident Conditions

8.3.2.1 Radiological Impacts

The estimated radiological impacts (radiation doses and LCFs) from potential accidents during the operation of full-scale (100%) storage facilities for depleted UF_6, U_3O_8, and UO_2 are presented in Section 6.3.2.1. The analysis of the 100% cases considered a range of accidents in four frequency categories; results are presented for only those accidents in each category that would have the greatest consequences (bounding accidents). Similar sets of accidents covering the same four frequency categories are defined in the engineering analysis report (LLNL 1997) for the 25% and 50% throughput cases.

Based on the assessment of the 25% and 50% long-term storage cases, the radiological accident impacts associated with each of the parametric cases would be the same as those presented for the 100% case in Section 6.3.2.1. The impacts would be identical because the bounding accidents within each frequency category would be the same for the 100%, 50%, and 25% cases. The bounding accidents would be the same because they would involve only a limited amount of material that would be at risk under accident conditions regardless of the facility size or throughput. However, as a result of the reduced throughput rates, the actual frequencies of some accidents that were related to handling operations (i.e., the "mishandle/drop of drum" accident) would decrease as the number of containers handled decreased. The resulting risk of these accidents would also decrease as their frequencies decreased. However, none of the accident frequencies would change enough to cause the accident to be considered in a different frequency category. Therefore, the overall impacts associated with the long-term storage options would be the same for all parametric cases.

8.3.2.2 Chemical Impacts

The estimated chemical impacts from potential accidents during the operation of full-scale (100%) storage facilities for UF_6 and oxide are presented in Section 6.3.2.2. The analysis of the 100% cases considered a range of accidents in four frequency categories; results are presented for only those accidents in each category that would have the greatest consequences (bounding accidents). Similar sets of accidents covering the same four frequency categories are defined in the engineering analysis report (LLNL 1997) for the 25% and 50% throughput cases.

Based on the assessment of the 25% and 50% long-term storage cases, the chemical accident impacts associated with each of the parametric cases would be the same as those presented for the 100% case in Section 6.3.2.2. As for radiological accidents, the impacts would be the same because the bounding accidents within each frequency category would be the same for the 100%, 50%, and 25% cases. The bounding accidents would be the same because they would involve only a limited amount of material that would be at risk under accident conditions regardless of the facility size or throughput. However, as a result of the reduced throughput rates, the actual frequencies of some accidents related to handling operations (i.e., the "mishandle/drop of drum" accident) would decrease as the number of containers handled decreased. The resulting risk of these accidents would also decrease as their frequencies decreased. However, none of the accident frequencies would change enough to cause the accident to be considered in a different frequency category. Therefore, the overall impacts associated with the long-term storage options would be the same for all parametric cases.

8.3.2.3 Physical Hazards

The estimated health impacts, such as on-the-job injuries and fatalities, from potential physical accidents during the construction and operation of full-scale (100%) storage facilities are presented in Section 6.3.2.3. For the 100% storage cases, worker fatalities ranged from about 0.10 to 0.25 for storage as UF_6, 0.14 to 0.16 for storage as UO_2, and 0.26 to 0.29 for storage as U_3O_8 (see Table 6.11 in Section 6.3.2.3). On-the-job worker injuries for the 100% cases ranged from about 90 to 150 for storage as UF_6, from 150 to 165 for storage as U_3O_8, and from 100 to 110 for storage as UO_2. For the two options analyzed in detail in the parametric analysis, the impacts of the 25% and 50% cases would be smaller than those for the 100% cases, although the decrease would not be proportional to the reduction in throughput (i.e., the impacts for the 50% case would be greater than 50% of the impacts for the 100% case).

For parametric cases, the number of on-the-job worker fatalities for storage as UF_6 would range from 0.05 to 0.08 at 25% capacity and from about 0.07 to 0.14 at 50% capacity. For storage as UO_2, fatalities would range from 0.07 to 0.10 at 25% capacity and would be about 0.10 at 50% capacity. The number of on-the-job worker injuries for storage as UF_6 would range from about 50 to 64 at 25% capacity and from about 60 to 93 at 50% capacity. For storage as UO_2, injuries would range from about 50 to 70 at 25% capacity and would be about 75 at 50% capacity. The predicted number of injuries for UF_6 and UO_2 are shown as a function of throughput in Figures 8.35 and 8.36, respectively.

Although parametric cases for the U_3O_8 storage options were not explicitly analyzed, if it is assumed that the relative difference in magnitude of impacts for U_3O_8 and UO_2 is similar to that for the 100% cases, then the number of on-the-job fatalities for storage as U_3O_8 would range from about 0.13 to 0.18 for 25% capacity and from about 0.19 to 0.21 at 50% capacity. Estimated injuries for parametric cases of storage as U_3O_8 would range from about 75 to 105 for 25% capacity and from about 113 to 125 for 50% capacity.

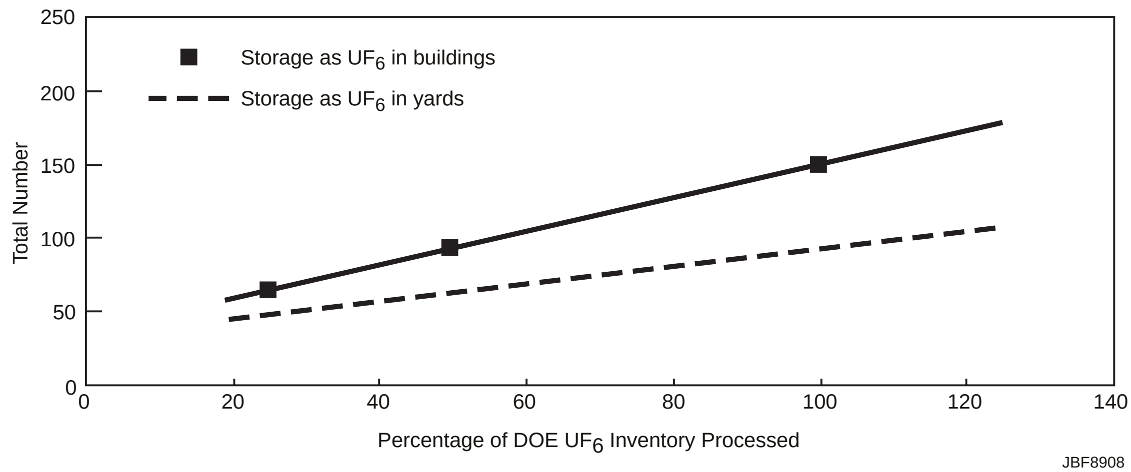

FIGURE 8.35 Estimated Number of On-the-Job Injuries (for entire construction and operational periods) for Storage as UF_6 (The range reflects differences in storage technologies, i.e., buildings and yards.)

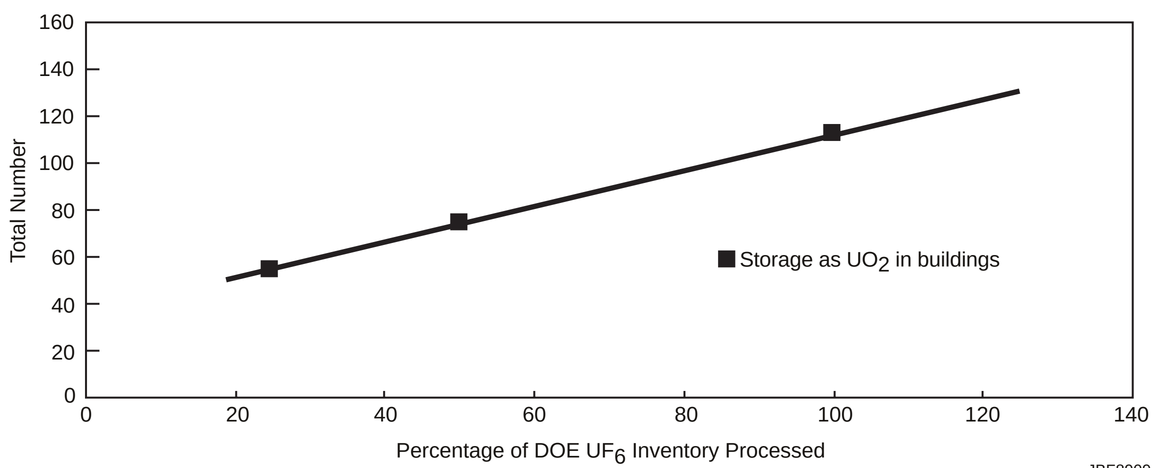

FIGURE 8.36 Estimated Number of On-the-Job Injuries (for entire construction and operational periods) for Storage as UO_2 (No range is presented because the estimates for storage in buildings and vaults are almost identical.)

8.3.3 Air Quality

The estimated impacts on air quality during construction and operation of full-scale (100%) long-term storage facilities for UF_6 and oxide are presented in detail in Section 6.3.3. All of the pollutant concentrations resulting from 100% throughput would be below the respective air quality standards. During construction, short-term particulate concentrations would potentially approach the applicable air quality standards for all options, although the condition would be temporary and minimized by good construction practices. During operations, the pollutant concentrations would be less than 0.1% of the corresponding air quality standards, resulting in negligible impacts.

The air quality impacts calculated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases. During construction, short-term impacts for the parametric cases would be less than those for the 100% cases; impacts during operations would also be negligible. The air quality impacts from storage were found to scale roughly proportionally with throughput. The impacts from the 50% case for both construction and operations would be about 0.6 of those from the 100% case for both UF_6 and UO_2; the impacts for construction for the 25% case would be 0.25 and 0.32 times the 100% case for UF_6 and UO_2, respectively; and the impacts for operations for the 25% case would be only about 0.2 times the 100% case for both UF_6 and UO_2.

8.3.4 Water and Soil

8.3.4.1 Surface Water

The estimated impacts on surface water during construction, operation, and potential accidents for full-scale (100%) storage facilities for UF_6 and oxide are presented in detail in Section 6.3.4.1. The potential impacts evaluated included changes in runoff, changes in quality, and floodplain encroachment. The impacts to surface water from the 100% cases were found to be negligible for all storage options for both UF_6 and oxide (including storage of U_3O_8). The impacts calculated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases, and thus would also be negligible.

8.3.4.2 Groundwater

The estimated impacts on groundwater during construction, operation, and potential accidents for full-scale (100%) storage facilities for UF_6 and oxide are presented in detail in Section 6.3.4.2. The potential impacts evaluated included changes in depth to groundwater, direction of groundwater flow, recharge, and groundwater quality. The impacts to groundwater from the 100% cases were found to be negligible for all storage options for both UF_6 and oxide (including storage of U_3O_8). The impacts calculated for the 25% and 50% parametric cases, based on information provided in the engineering analysis report (LLNL 1997), were found to be less than those for the 100% cases, and thus would also be negligible.

8.3.4.3 Soil

The estimated impacts to soil during construction, operation, and potential accidents for full-scale (100%) long-term storage facilities for UF_6 and oxide are presented in detail in Section 6.3.4.3. The potential impacts evaluated included changes in topography, permeability, quality, and erosion potential. The impacts to soil from the 100% cases were found to have potentially moderate, but temporary, impacts for all storage options. These moderate impacts would result from material excavated during construction that would be left on-site. In the long term, contouring and reseeding would return soil conditions back to their former state, and the impacts would be negligible. The impacts calculated for the 25% and 50% parametric cases for storage of UF_6 and UO_2 in buildings, based on information provided in the engineering analysis report (LLNL 1997), were also found to have moderate, but temporary, impacts on soil, similar to the 100% cases. In the long term, impacts on soil would be negligible for all storage options.

8.3.5 Socioeconomics

The socioeconomic impacts of UF_6 and UO_2 long-term storage facilities for the 50% and 25% parametric cases would be less than the impacts of the base-case facility sizes. Cost information was not available in sufficient detail to allow an analysis of impacts using the same methodology that was used for the base cases. The impacts of parametric cases were therefore assessed qualitatively, based on the assumption that changes in the cost of equipment, materials, and labor would be proportional to changes in total life-cycle cost. Compared with base-case facility sizes, smaller UF_6 and UO_2 long-term storage facilities would result in the following: less direct and indirect employment and income in the ROI would be created at the site; fewer people would migrate into the ROI with fewer total jobs created, meaning fewer rental and owner-occupied houses would be needed; and the impact on local jurisdictional revenues and expenditures would be smaller.

8.3.6 Ecology

Impacts to ecological resources could occur during construction of UF_6 storage facilities for all options, although impacts during operations would be negligible. Impacts due to construction and operation of a facility to store UO_2 in buildings would be similar to impacts from storage of UF_6. Site preparation activities would result in the disturbance of biotic communities, including the permanent replacement of habitat with structures and paved areas (see Section 8.3.9). Existing vegetation would be destroyed during land-clearing activities. Wildlife would be disturbed by land clearing, noise, and human presence.

Depending on the exact location of the UF_6 facility, the loss of 40 to 130 acres (16 to 53 ha) of undeveloped land and habitat might constitute a moderate to large adverse impact to vegetation and wildlife. (See Section 8.3.9 for details on land use assumptions.) Depending on the exact location of the UO_2 facility, the loss of 40 to 80 acres (16 to 32 ha) of undeveloped land and habitat might constitute a moderate adverse impact. However, when these facilities were sited, all appropriate measures would be taken to preclude or minimize such impacts.

Impacts to wetlands and state and federally protected species due to facility construction would depend on the location of the storage facility within the Portsmouth site. Avoidance of wetland areas and site-specific surveys for protected species would be included during facility planning.

8.3.7 Waste Management

The estimated impacts from waste management operations from the construction and operation of full-scale (100%) long-term storage facilities for UF_6 and oxide are presented in detail in Section 6.3.7. On the basis of information provided in the engineering analysis report (LLNL 1997), the impacts resulting from construction and operation of the long-term storage facility for the 25% and 50% parametric cases would be roughly linear for throughput ranges of between 25% and 100%. Minimal to moderate, but temporary, waste management impacts would result from construction wastes. Negligible impacts would be associated with all waste forms generated during operations. Overall, the waste input resulting from storage facilities would have negligible impact on waste management capacities locally or across the DOE complex.

8.3.8 Resource Requirements

The estimated impacts from resource requirements during construction and operation of full-scale (100%) long-term storage facilities for UF_6 and oxide are presented in detail in Section 6.3.8. The impacts on resources would be expected to be small for the 100% capacity storage case for all options. Resource requirements for the two parametric cases considered would be less than those for the 100% case (LLNL 1997). In general, the amounts of construction materials would be roughly proportional to the storage capacity because the majority of the construction materials would be for the actual storage buildings and the number of storage buildings required would be linearly related to the required storage capacity.

Construction and operation of the proposed storage facilities would consume irretrievable amounts of electricity, fuel, concrete, steel and other metals, water, and miscellaneous chemicals. The total quantities of commonly used materials would not be expected to be significant. No strategic and critical materials (e.g., Monel or Inconel) in significant quantities are projected to be consumed during construction or operation for all long-term storage options. The storage options are not considered resource-intensive, and the resources required are generally not considered rare or unique. Furthermore, committing any of these resources would not be expected to cause a negative impact on the availability of these resources within local areas or nationally for the 100%, 50%, and 25% cases.

8.3.9 Land Use

Impacts to land use from the construction and operation of UF_6 storage buildings would be limited to the clearing of required land, potential minor and temporary disruptions to contiguous land parcels, and a slight increase in vehicular traffic. Site preparation for construction of a facility to store 25%, 50%, and 100% of the depleted UF_6 inventory in buildings would require the disturbance of approximately 42, 72, and 131 acres (17, 29, and 53 ha), respectively. Within this disturbed area, the facility would require the permanent replacement of approximately 16, 30, and 62 acres (6.5, 12, and 25 ha) with structures and paved areas. The amount of land required for the other UF_6 storage options would be generally similar.

Land for storage buildings would be cleared incrementally over the projected 20-year construction project, thereby reducing the potential for land disturbance and consequential land disruption impacts. Such potential impacts, however, would be greatest at 100% of throughput capacity. Also, the areal requirement of 131 acres (53 ha) for the 100% capacity case could result in land-use changes if an existing site with limited open space were chosen.

Road and rail access within a storage site would be designed to minimize on-site traffic conflicts. For off-site traffic, only temporary, minor impacts associated with construction vehicles would be expected.

Storage as UO_2 would be expected to generate only negligible impacts to land use and would result in a lower areal requirement and less land disturbance compared with storage as UF_6. Site preparation for the construction of a facility to store 25%, 50%, and 100% of the depleted UF_6 inventory as UO_2 in buildings would require the disturbance of approximately 37, 49, and 79 acres (15, 20, and 32 ha), respectively. Within this disturbed area, the facility would require the permanent replacement of approximately 13, 20, and 35 acres (5.1, 8.1, and 14 ha) with structures and paved areas. The amount of land required for the other uranium oxide storage options would be generally similar.

Land for storage buildings would be cleared incrementally over the projected 20-year construction project, thereby reducing the potential for land disturbance and consequential land disruption impacts. Such potential impacts, however, would be greatest at 100% of throughput capacity. The peak labor force during the 20-year construction period, regardless of throughput capacity, would not be large enough to generate other than negligible off-site traffic impacts.

8.3.10 Other Impacts Considered But Not Analyzed in Detail

Other impacts could potentially occur if the long-term storage options considered in the PEIS were implemented — including impacts to cultural resources and environmental justice, as well as to aesthetics (e.g., visual environment), recreational resources, and noise levels, and impacts associated with decontamination and decommissioning of storage facilities. These impacts, although considered, were not analyzed in detail for one or both of the following reasons:

- The impacts could not be determined at the programmatic level without consideration of specific locations for construction at the Portsmouth site, which are not currently known. These impacts would be more appropriately addressed in the second-tier NEPA documentation when specific sites are considered.

- Consideration of the impacts would not contribute to differentiation among the alternatives; therefore, it would not affect the decisions to be made in the ROD for the PEIS.

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DOE: see U.S. Department of Energy.

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